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Streamlining Supply Pick Operations for the United States Postal Service

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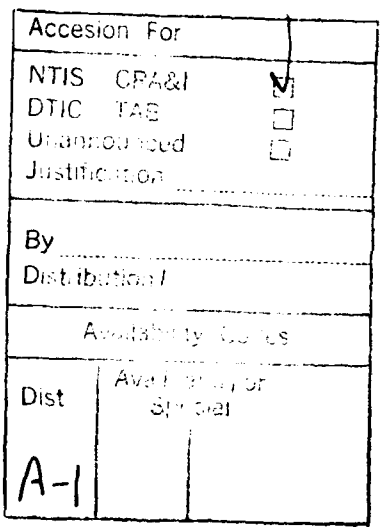

Samuel J. Mallette

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Executive Summary

STREAMLINING SUPPLY PICK OPERATIONS FOR THE UNITED STATES POSTAL SERVICE

The United States Postal Service (USPS) distributes supplies, repair parts, and equipment across the country from materiel distribution centers (MDCs) in Somerville, N.J., and Topeka, Kan. Those MDCs ship both loose-issue and case-lot quantities of materiel, and each devotes the equivalent of 24 full-time employees to its loose-issue pick-and-pack operations. USPS Materiel Distribution seeks to find more cost-effective ways to manage those loose-issue pick-and-pack operations while at the same time maintaining current service response times to its customers.

The USPS can eliminate between 11 and 15 full-time employees at each MDC by reconfiguring its supply pick lines and investing in new material-handling technology. We recommend a new layout for this reconfiguration that uses one line instead of three and increases the amount of product directly accessible to pickers on the line from 28 percent to 60 percent. It is focused around separating high-activity items from low-activity items and treating them differently. The 341 high-activity items would be stored in gravity flow racks with pick lights attached to each location for improved pick productivity. The 2,147 low-activity items would be stored in horizontal carousels utilizing batch-pick software and light pick aids. Orders would be picked sequentially from zones in a pick-and-pass fashion to eliminate the need for consolidation. The reconfigured line would contain an early exit for orders completed before they have traveled through all zones. The pack operation on the new line should be automated as much as possible; our proposed layout utilizes a random case sealer for most outgoing containers. Packing is treated as another zone on the pick line. The new layout would cost approximately $414,000 at each MDC and would require 1 year to develop and install; it would then pay for itself in less than a year.

Materiel Distribution also wants suggestions for repair part pick line improvements at its Topeka MDC. While we did not fully analyze alternatives for repair part picking, we believed that labor requirements can be reduced by about half if the center uses horizontal carousels or other technology capable of bringing product

to the pickers. The labor savings opportunity in that operation is small when compared to the supply pick line operation because only 13 employees are allocated to it.

Finally, USPS Materiel Distribution wants to understand the desirability of combining the two MDC supply pick operations. Although that concept was not the main focus of our study, we believe that combining MDC supply pick line operations will not offer any direct labor savings but may result in some indirect and overhead savings. The USPS needs to analyze the effects of this change on inventory investment, outbound [illegible]rtation costs, inbound transportation costs, and shipping times to post offices to fully understand its impact.

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CHAPTER 1

INTRODUCTION

The United States Postal Service (USPS) distributes supplies, repair parts, and equipment through a multi-echelon network consisting of multiple retail stocking sites, hundreds of warehouse facilities, and three wholesale materiel distribution centers (MDCs) serving the entire country. The USPS operates warehouses using a mix of relatively old technology and equipment. It ships both loose-issue and case-lot (bulk) quantities of materiel from those MDCs. USPS Materiel Distribution seeks to find more cost-effective ways to manage its internally run operations while at the same time maintaining current service response times to its customers.

This study focuses on supply pick line operations at materiel distribution centers (MDCs) in Somerville, N.J., and Topeka, Kan. Each MDC pick-line operation is allocated 27 employees and processes in excess of 5,000 loose-issue line items a day.[1] They each receive between 500 and 1,000 orders a day through the mail stream, and combined, they ship to 17,000 different addresses. Their customers are post offices across the United States.[2]

Each MDC loose-issue pick operation for supply items has three pick lines. Each of those pick lines consists of one row of back-to-back static-bin shelving (100 to 150 feet long) surrounded by a nonpowered roller conveyor. The lines are broken into two to six pick zones, and each zone is manned by a picker who picks all products in the zone for an order and passes that order to the next zone for picking there. The orders are transported on the roller conveyor. A particular customer's order is picked simultaneously on all three lines and the individual boxes of picked items from these three lines are then consolidated. Consolidated orders are then packed and shipped. Loose-issue pick lines are not consolidated with bulk pick lines prior to shipment.

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[1]Each MDC currently uses 24 employees; however, each is allocated a total of 27 positions.

[2]The USPS has approximately 35,000 post offices across the United States. The small post offices get supply items from the larger ones, thereby reducing the number of Materiel Distribution customers.

The USPS Materiel Distribution management seeks to reduce the amount of labor required to operate these loose-issue pick lines and wants to know what kind of improvements are needed to do so. The USPS also wants to understand how combining the Topeka and Somerville MDC operations would affect labor requirements, although it did not include that aspect of the study in our tasking.

The Topeka MDC also operates pick lines for issuing repair parts for postal equipment. Those lines are allocated a total of 13 employees to pick and pack 1,400 line items a day. The MDC ships parts to 900 maintenance storerooms at mail processing and distribution centers across the country. The two primary repair part lines contain 9,000 items combined. Each of the two part lines is 130 feet long and consists of one nonpowered roller conveyor surrounded on both sides by "cells" of parts stored in various types of bin shelving. Each side of each line has six cells, and each cell contains a U-shaped layout of static-bin shelving and rotobins with several different shelf spacings to provide all different sizes of part locations. The U layout also contains a pick table in the middle with bins surrounding it. As an ancillary aspect of our study, we assessed the repair part pick operation to determine whether it can be improved.

In the study, we visited both MDCs to document the specific details of their order-picking processes. USPS Materiel Distribution provided us with data for our analysis, including picking activity records, productivity logs, and physical facility information. In Chapter 2, we present our findings and conclusions based on visits to each MDC and on analyzing data provided to us by USPS Materiel Distribution.[3] Based on conclusions drawn from our site visits and our analysis of data provided, we identified six alternative strategies for the pick lines that have a common conceptual layout. In Chapter 3, we present our analysis of those alternatives. In Chapter 4, we present our supply pick line recommendations, and in Chapter 5, we present some general observations about combining MDC operations and some suggestions for making improvements to the repair part pick lines.

[3]We do not address bulk picking, receiving, or shipping operations. We have assumed that the range and depth of items stocked will remain constant and that customer ordering patterns will remain the same.

CHAPTER 2

FINDINGS AND CONCLUSIONS

SITE VISITS

We visited the Somerville MDC to understand how the supply item pick lines are currently organized, the specific details of the order picking process, the equipment used, and employee productivity. We then visited the Topeka MDC to understand the differences between the supply item pick lines there and the ones in Somerville. In general, we found the two operations to be nearly identical in all respects, including workload, design, and productivity. We also documented the organization of the repair part pick lines and associated processes at the Topeka MDC. In the following sections we present our findings from our site visits.

Goals

We found that in both facilities, management had two improvement goals: improve order turnaround time and decrease labor requirements. Order turnaround time is measured from the time the facility receives the order from the customer to the time the order is shipped out of the facility. Management at both facilities indicated to us that they were currently taking 72 hours to process an order, 24 hours of which is overnight system processing time, and at both facilities, management believes that the warehouses can and should process the orders within 24 hours.

Each facility currently has 27 positions in its supply pick lines, and each ships about 5,000 line items a day. Those pick line operations include replenishment from bulk, picking of loose-issue items, and packing activities. Improvement opportunities mentioned by the MDC managers include use of power conveyors on lines, improved systems support, and different kinds of storage.

Products

Walks down all of the pick lines revealed that most of the product on those lines is paper of some type. We saw forms, manuals, printed matter, envelopes, labels, and some office items such as rubber stamps, sponges, finger pads, or grease-resistant

envelopes for stamps. We observed that for many of these items – for forms in particular – maintaining accurate inventories is difficult. The forms are not packaged in convenient pick quantities. When pickers get an order for 100 copies of a particular form, they pull an approximate amount based on their knowledge of how thick 100 forms will be, a practice known as "pinch picking." The other important observation that we made about the products on the pick lines is that they are not fragile. Because they are not fragile, less protective packaging is required and packing is more easily automated.

Productivity

Our impression of pick productivity is that efficiency is adequate but utilization is low. Efficiency is a measure of the speed at which a particular task is performed when it is being performed. It reflects how well the employees do the jobs they are assigned. In general, we did not detect serious problems with employee efficiency.

We did, however, detect problems with employee utilization. Utilization is the amount or percentage of time that the employees spend doing their principal tasks – in this case order picking. We observed many interruptions in the pick process: waiting for more orders to come down the line, replenishing bin locations from backup stock, walking off the line to pick an item, moving material down the line manually, and walking to bin locations.

Item Storage

The way the items are currently stored leaves much room for improvement. Currently, multiple items are stored in one location, which means that pickers must look at location numbers and item numbers when picking from their pick sheets.[1] All of the locations were of identical size: product is stored on shelves 3 feet wide, 2 feet deep, and 1 foot high. That configuration cannot accommodate large stocks of highly active items and causes wasted space for slow-moving items. In fact, we did not see any differentiation between high-volume items and low-volume items on the lines, except that pick zones were sized to approximately equalize the work between zones; that is, the large zones have more slow-moving items and the small zones have more fast-moving items.

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[1]Some pickers know their items so well that they do not look at bin locations at all; they simply look at the item identification number and know exactly where it is.

Systems Deficiencies

We observed both operational and structural problems with current systems support. Operationally, we noted at both MDCs that while the pick line operation starts work at 7:30 a.m. each day, orders do not arrive for picking until 10:00 a.m. In effect, that approach causes the pick line supervisors to plan on having orders from the previous day left over to pick in the morning. We also noted that the pick documents (labels, lists, and tickets) must be sorted and collated either by order-processing personnel or by warehouse personnel. All pick documents should be presorted by the computer system and should be printed on one common form with peel-off or tear-off parts as necessary.

Structurally, we noted three problems with systems support. First, the system cannot track inventory by location. It recognizes only total on-hand balances that are located in both the bulk and loose-issue areas. Thus, the system cannot produce suggested replenishments of loose-issue stock from bulk locations.[2] Second, the system does not have a location file with information about the size, type, and utilization of each location. Without such a file managing the assignment of items to appropriate locations is difficult (e.g., large items or high-volume items need big locations). Third, the system does not contain item dimensional information about the products, making it difficult to plan space requirements for both storage and packing of items.

Pick Strategy

Both MDCs follow a zone pick strategy for supply items, utilizing both pick-and-pass and pick-and-consolidate methods. The pick-and-pass method is one in which orders are picked in one zone and then passed to the next zone for picking there. A successful pick-and-pass strategy is highly dependent on having zones with equal workload and employees with equal productivity working in those zones. The pick-and-consolidate strategy is one where orders are picked simultaneously in all zones and then merged or consolidated afterward. The pick-and-consolidate method adds labor because items picked from different zones must be consolidated. Within each pick line, the pick-and-pass method is used, but across pick lines, the pick-and-consolidate strategy is used. The net result is that each order consists of products

[2]Automated replenishment is further complicated by the fact that inconsistencies between physical and system balances develop quickly over time as a result of pinch picking practices.

coming from each of the three lines simultaneously. Orders are not batched but are picked one at a time within a zone.

Pick Job Content

Actual pick activity is relatively low in labor intensity. Items do not have to be marked or packaged by pickers. They simply take the item from the shelf and put it in the pick container for the order they are picking. Some guessing is required on the part of the pickers because they do not count forms (they use the pinch pick method). We also noticed that some of the pick zones cover large amounts of floor space and require significant amounts of walking to complete the picks. Each order travels the entire length of at least one pick line and in many cases, all three pick lines. Although it is not obvious, the pickers travel almost the same distance for each order picked. The pick time is low, but interruptions such as getting stock from backup areas and walk time add significantly to it.

Pack Job Content

The packing job, too, is not labor intensive. Orders arrive in a container suitable for shipping. In some cases, the products must be combined into one shipping carton and in other cases a smaller carton is made up and the items are put into it. Packing material may be added to the container but the items inside are not generally fragile. In most cases, special markings are not required. A packing label is affixed to the box and, in the case of the Somerville operation, the standard size boxes are sent down the pack conveyor line for automated sealing. The packers at Somerville manually seal cartons that are not the standard size. In Topeka, all cartons are sealed manually at the packing stations.

DATA ANALYSIS

In our visits to Somerville and Topeka, we obtained data on the items distributed, the loose-issue activity, storage space used, and productivity. In the following subsections we summarize the results of our analysis of those data.

Item Activity Analysis

We performed an item activity analysis of the loose-issue supply items and found that the relationship between the percentage of items and the percentage of line item activity is *highly* skewed. This analysis, commonly known as "ABC"

analysis, was performed using data from Accounting Period 6 in FY93.[3] We ranked the items by descending order of loose-issue, line-item transactions and then broke them into five categories: AA, A, B, C, and CC items. The AA items are those at the top of the ranking that account for 50 percent of the line-item demands; the A items account for the next 30 percent of line-item demands; the B items account for the next 15 percent of line-item demands; the C items account for the remaining 5 percent of line-item demands; and the CC items are those with no activity.

The results of our ABC analysis are shown in Table 2-1. The analysis revealed that 3.3 percent of the items (86 items) account for 50 percent of the demand and another 9.7 percent of the items (255 items) account for the next 30 percent of demand. These are the AA and A items, respectively. Out of 2,637 items, only 341 or 12.9 percent are high-volume items. Of the 2,637 items, 558 were B items, 1,589 were C items, and 149 were CC items.

TABLE 2-1

ABC SUMMARY ANALYSIS BY ISSUE TRANSACTIONS

Item category	Number of items	Percentage of items	Lines demanded	Percentage of lines demanded	Units demanded	Percentage of units demanded
AA	86	3.26	110,364	50.24	15,566,122	68.03
A	255	9.67	65,471	20.80	4,721,933	20.64
B	558	21.16	32,868	14.96	1,928,360	8.43
C	1,589	60.26	10,983	5.00	663,708	2.90
CC	149	5.65	0	0.00	45	.00

Storage Space Analysis

We analyzed the storage space used in the loose-issue pick areas at both sites and found that much of it was not accessible from the pick lines. Table 2-2 shows the results of our calculations. At the Somerville MDC, of the 18,725 cubic feet of space used, bin space used accounts for 4,301 cubic feet or 22.9 percent. At Topeka, of the 19,320 cubic feet of space used, bin space used accounts for 6,489 cubic feet or

[3]The USPS has indicated that these data are generally representative of data from other accounting periods as well.

33.6 percent. The remaining product is stored under the conveyor line, on a table behind the conveyor line, or on pallets behind the lines. All of the locations we measured were either on the lines or considered backup stock; none were part of bulk stock.

TABLE 2-2

SUPPLY LINE STORAGE SPACE ANALYSIS

(Cubic feet)

Storage type	Usage	Somerville	Topeka
Bins	Available[a]	6,420	8,652
	Used	4,301	6,489
Pallets	Available	18,624	22,272
	Used	9,312	11,136
Table/Floor	Available	8,520	3,390
	Used	5,112	1,695
Total	Available	33,564	34,314
	Used	18,725	19,320

[a]Does not include empty shelf locations.

Cubic Volume Requirements

We determined that the supply items take up an average of 1.3 cubic inches per unit. Although data on the amount of loose-issue inventory on hand and cubic space per item were not available, we were able to compute the average size of an item by understanding the number of units picked per day, the number of items stocked, the number of replenishments from bulk per day, and the total space taken by all loose-issue items.[4] For comparison purposes, the average item size of 1.3 cubic inches per unit is the equivalent of about 3.5 pages of 8.5 inch by 11 inch 20 pound paper stock. In this analysis, we also noted that each item has an average of 44 days of supply on hand in the loose-issue area.

[4]The computation for each facility uses 572,004 units issued per day, 2,637 items stocked, 60 replenishments from bulk per day, and 19,022.5 cubic feet of storage space.

Commodity Analysis

We grouped the items by item type and found that forms comprise 47.8 percent of the supply lines demanded in loose-issue quantities. Table 2-3 shows the results of this analysis. Most of the items are, in fact, some kind of paper.

TABLE 2-3

COMMODITY ANALYSIS

Item type	Number of items	Percentage of items	Lines per accounting period	Percentage of lines picked
Forms	985	37.35	104,969	47.78
Office supplies	441	16.72	30,474	13.87
Labels	158	5.99	29,097	13.24
Envelopes	42	1.59	22,667	10.32
Notices	84	3.19	5,659	2.58
Publications	120	4.55	4,636	2.11
Posters	64	2.43	4,203	1.91
Handbooks	231	8.76	3,827	1.74
Rubber stamps	79	3.00	3,475	1.58
Custodial supplies	40	1.52	2,694	1.23
Delivery	27	1.02	2,621	1.19
Other	366	13.88	5,364	2.45

Productivity

Our examination of supply pick line productivity data (labor hours and lines shipped) revealed pick rates of 32 lines per hour at Topeka and 33 lines per hour at Somerville. These calculations are for the total work force involved in loose-issue picking and packing at each site. We were able to obtain some data from the Somerville operation about the breakdown of those pick rates between actual picking activity and other activity. Those data reveal that pickers are picking at an average rate of 78 lines an hour and performing other activities (packing, replenishing, etc.) at an average rate of 63 lines shipped per hour consumed.[5] Even though those

[5]Some of the other activities are related to the picking operation and, we believe, cause the true pick rate to be approximately 60 lines per hour.

numbers are high in comparison to other manual operations, our earlier observation that the work content in both the picking and packing areas is low, leads us to believe these productivity rates could be much higher.

CONCLUSIONS

On the basis of our site visits and our data analysis, we conclude that improvements resulting in decreased labor requirements and improved system response time are possible. Those improvements can be made by treating high- and low-activity items differently, modifying the zone picking strategy employed, and making systems improvements.

Items should be stored and picked according to their ABC rankings. We observed that much of the loose-issue item storage was off the pick lines and that pickers have to frequently refill high-activity item locations on their line (or go off the line to pick the items). It makes sense to use larger, deeper locations for these items and to concentrate them in one area. We also observed that in zones where low-activity items were located, considerable walking was required to fill the orders. Smaller locations and a more efficient system for retrieving those items are needed.

A zone-picking strategy makes sense, but the current strategy needs to be changed. The current strategy has the disadvantages of requiring balanced zones and extra work to consolidate orders. The zones should be connected by power conveyor to eliminate walking time and in each zone, a take-away conveyor should feed directly to the pack areas for completed orders. Although the pick-and-pass strategy requires a balanced line in terms of equal workload in each zone, it is more desirable because it eliminates the need to consolidate orders coming from the various zones. The number of zones should be calculated based on expected pick rates and average number of hours desired to complete the work.

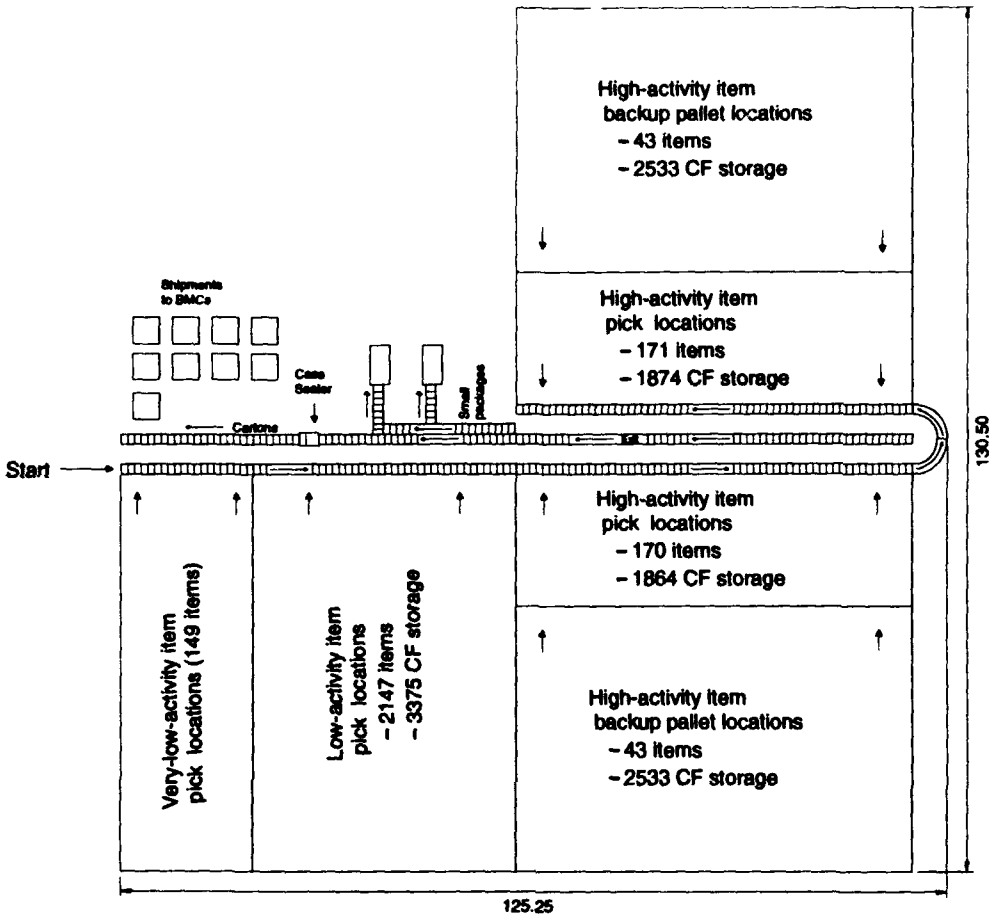
Improvements to the current systems operation are needed to support increased productivity and decreased turnaround time. All manual sorting and collating of labels, pick tickets, and pick sheets must be eliminated. It can be eliminated through use of one multipurpose form that contains all the paperwork needed to pick an order. All sorting should be done electronically prior to printing. The scheduling of order processing on the computer system should be rearranged to accommodate the pick line schedule; in a batch environment, all orders should be printed by 7:30 a.m. In a

real-time environment, orders should be printed throughout the day as they are received.

Improvements to the current systems structure are also needed to support Materiel Distribution's goals. The system must be capable of supporting an environment where pick instructions are issued by the system to the pickers as they pick. This requirement is critical to improving productivity and pick accuracy. The system should also recognize on-hand balances of a product in location in which that product is stored. This improvement would provide the foundation for developing system-recommended, loose-issue replenishments from bulk stock. The system should also contain a location file with information about what is in that location and its type and size. That information will allow constant monitoring of location utilization and can even be used to assign locations to incoming products. Lastly, the system should contain information about item dimensions to plan space requirements and to continually rewarehouse slow-moving items out of high-moving item storage and vice versa.

Figure 2-1 illustrates a conceptual layout incorporating the separation of high- and low-activity items and the modified zone picking strategy. Order picking starts at the head of the very-low-activity item pick locations (lower left corner) and proceeds counterclockwise about the layout. Very-low-activity items are stored in static bin shelves and are picked manually off of pick sheets. The next zones are for low-activity items. Those items could be stored in either static-bin shelving or in horizontal carousels. Finally, the remaining zones are for high-activity items that contain forward storage utilizing either static-bin shelving or gravity flow rack (with or without light aids). Behind those locations are areas for pallets of backup stock to refill the forward locations. Once all picks are complete, orders flow either directly to a case sealer or to a packer for packaging into small containers such as envelopes or jiffy bags. Only one line is used, but the number of zones for each type of item will vary depending on the exact type of storage and pick method used.

Table 2-4 shows the number of locations and amount of storage in cubic feet needed for three types of zones: high-activity zones (AA and A items), low-activity zones (B and C items), and very-low-activity zones (CC items). These requirements are based on storing 4 weeks of supply in the high-activity zones and 12 weeks of



Notes: (1) All dimensions are in feet. (2) Drawing is to scale. (3) BMC = Bulk materiel center. (4) CF = cubic feet.

FIG. 2-1. USPS SUPPLY ITEM PICK LINE CONCEPTUAL LAYOUT

supply in the low-activity and very-low-activity zones.[6] The calculation also assumes that 100 percent of the A item stock and 25 percent of the AA item stock are located in the forward pick areas in the high-moving zones and the remaining 75 percent of the AA item stock is stored on pallets behind the forward pick areas in the high-activity zones. The conceptual layout in Figure 2-1 incorporates these requirements. It also increases the amount of loose-issue storage directly accessible

[6]These values generally reflect current levels.

to the pickers from 28 percent to 60 percent of total loose-issue area storage space.[7] What remains to be determined are the types of storage to be used in the zones and the method for picking from them.

TABLE 2-4

STORAGE REQUIREMENTS BY ZONE TYPE

Type zone and item	Maximum units stored	Number of slots	Cubic feet required
High-activity zones			
AA items	7,783,061	86	6,756
A items	2,360,967	255	2,049
Bin/GFR	4,306,732	341	3,738
Backup pallet	5,837,296	86	5,067
Low-activity zones			
B items	2,892,540	558	2,511
C items	995,562	1,589	864
Bin/HC	3,888,102	2,147	3,375
Very-low-activity zones			
CC items	68	149	0
Bin	68	149	0

Notes: (1) High-moving zones are sized to contain 4 weeks of supply. Bins or gravity-flow racks contain 1 week of supply for AA items and 4 weeks of supply for A items. Backup pallet locations contain 3 weeks of supply for A items. (2) Low-moving zones are sized to contain 12 weeks of supply. (3) Average unit cube used is 1.5 cubic inches. (4) Average number of replenishments required per day from bulk is 55. (5) Depth of item inventories generally reflects current levels. (6) GFR = gravity-flow rack and HC = horizontal carousel.

We conclude that it is appropriate to analyze different combinations of storage and picking methods for the high- and low-volume items within the conceptual layout we have defined. Specifically, this analysis must answer four questions:

- What impact does splitting the high- and low-activity items have over the current operation?

[7]In the current layouts at each MDC, approximately 5,400 cubic feet out of 19,000 cubic feet are directly accessible from the lines. In the new conceptual layout, 7,113 cubic feet out of 12,179 cubic feet are directly accessible from the line.

- What impact does the use of gravity-flow racks have on picking of high-activity items?
- What impact does the use of light picking aids have on gravity-flow rack picking of high-activity items?
- What impact does the use of carousels and batching have on picking of low-activity items?

In Chapter 3, we answer those questions by analyzing six different combinations of storage and picking methods.

CHAPTER 3

ANALYSIS OF ALTERNATIVES

In this chapter, we describe and analyze six alternative supply line storage and pick configurations. Each alternative applies to only one MDC (Topeka or Somerville) and consists of the conceptual layout presented in Figure 2-1 with different combinations of flow racks, carousels, and picking aids. Our results include costs, annual dollar savings, full-time-equivalent (FTE) employee reduction, net present value, internal rate of return, and discounted payback period for each alternative and for each improvement made within a particular alternative. We also identify the sensitivity of those results to changes in key parameters of the analysis.

DESCRIPTION OF ALTERNATIVES

Our analysis focuses on picking and item storage. The alternatives vary by type of item storage used for fast movers, type of item storage used for slow movers, and use of software and hardware aids to enhance picking productivity. We considered (1) the use of bins and gravity-flow rack storage of fast-moving (AA and A) items in conjunction with palletized backup stock and (2) the use of bins and horizontal carousels for storage of slow-moving (B and C) items. In the case of gravity-flow racks, we analyzed alternatives with and without a warehouse control system capable of providing pickers with pick instructions that control light aids attached to the racks to facilitate more productive picking. In the case of carousels for low-activity items, we incorporate computer-controlled batching of orders to speed up the pick process.

All of the alternatives use the basic layout presented in Figure 2-1. Orders are picked in three types of zones: the first type is for fast movers (AA and A items), the second is for slow movers (B and C items), and the last is for very slow movers (CC items). The number of each type of zone differs by alternative because of different pick rates. Orders are picked using a pick-and-pass strategy. If an order is complete before reaching the last zone, it can be put on a take-away conveyor that feeds directly to the pack area for shipping. The pack area contains a direct feed to a random case sealer and diverters for up to two pack stations for packing small orders

in jiffy bags or envelopes. At the end of the line, sealed cartons are placed on pallets according to the bulk materiel center to which they will be sent.

Table 3-1 shows the differences among the alternatives. Each alternative incorporates the conceptual (revised) layout, one of three types of storage for the high-activity items, and one of two types of storage for the low-activity items. The three possibilities for the high-activity items are static-bin shelving, gravity-flow racks, and gravity-flow racks incorporating light picking aids and associated software. The two possibilities for the low-activity items are static-bin shelving and horizontal carousels with software for batch-picking control.

TABLE 3-1

ALTERNATIVES

Characteristic	Current	1	2	3	4	5	6
Layout							
Current	X						
Revised		X	X	X	X	X	X
High-activity storage							
Static-bin shelving	X	X			X		
Flow racks			X			X	
Flow racks with lights				X			X
Low-activity storage	X						
Static-bin shelving		X	X	X			
Carousels					X	X	X

The number of fast-, slow-, and very-slow-moving item zones varies by alternative because the productivity that can be obtained in each alternative is different. To compute the number of zones required, we first estimated the pick rates that could be achieved in each of the alternatives by zone type. We calculated our

pick rates by applying improvement factors to the current pick rate of 60 lines per hour (includes actual pick time plus time for refills and other pick-related work). We used the following factors:

- Concentrating high-activity items together results in 30 percent faster picking productivity (resultant pick rate is 78 lines per hour).
- Concentrating low-activity items together results in 30 percent slower picking productivity (resultant pick rate is 42 lines per hour).
- Using gravity-flow racks results in 50 percent faster picking productivity for high-activity items because frequent refills and walk-arounds are eliminated (resultant pick rate is 108 lines per hour).
- Using light picking aids and associated software on gravity-flow racks results in 100 percent faster pick productivity than flow rack picking from paper forms (resultant pick rate is 168 lines per hour).
- Using horizontal carousels and batch picking for low-activity items results in 150 percent productivity improvement because it eliminates walk time (resultant pick rate is 132 lines per hour).

We believe these factors to be reasonable for this analysis.[1] We perform sensitivity analysis on them later. Table 3-2 shows the resulting pick rates and number of each type of zone required for performing all picking within an 8-hour time frame with 12.5 percent of that time allowed for breaks and interruptions.[2] The resulting number of zones required is 12, 10, 8, 9, 7, and 5 for Alternatives 1 through 6, respectively.

ANALYSIS OF DATA

The data used in our analysis come from two sources: USPS Materiel Distribution and a local material-handling vendor. USPS Materiel Distribution provided us with information on pick activity, current productivity, manpower costs, and facility costs. All equipment cost information was supplied by a material-handling vendor in the form of General Services Administration Federal Supply Schedule rates or in the form of a budgeting estimate. In our financial

[1]In addition to using our own personal experience, we queried two separate vendors on their experience with these types of improvements. In all cases, the factors we used result in smaller improvements than those actually experienced.

[2]Final design may be done around a less-than-8-hour time period to accommodate peak demand days or lower-than-estimated productivity levels.

TABLE 3-2

PRODUCTIVITY, HOURS, AND ZONES FOR EACH ALTERNATIVE

Productivity/Hours/Zones	Alternatives					
	1	2	3	4	5	6
Low-activity items (LPH)	42.0	42.0	42.0	132.0	132.0	132.0
High-activity items (LPH)	78.0	108.0	168.0	78.0	108.0	168.0
Low-activity items (hours)	26.1	26.1	26.1	8.3	8.3	8.3
High-activity items (hours)	56.4	40.7	26.2	56.4	40.7	26.2
Low-activity items (zones)	3.7	3.7	3.7	1.2	1.2	1.2
High-activity items (zones)	8.1	5.8	3.7	8.1	5.8	3.7
Total zones required	11.8	9.5	7.5	9.3	7.0	4.9

Notes: LPH = lines per hour. Zone calculations are based on an 8-hour workday with 12.5 percent of time allowed for breaks and interruptions.

analysis we use an 8 percent cost of capital (directed by USPS) and a 5-year planning horizon. The actual data used are shown in Appendix A.

RESULTS

We used a three-step process to compute our results. First, we determined the required labor to support each alternative by deriving picking FTE requirements from the number of zones calculated above, by eliminating the consolidator job, and by reducing packing FTE requirements to 3, a number we believe to be adequate to support the new layout.[3] Second, we computed total costs and savings associated with each alternative by identifying the types, quantities, and costs of new equipment required, and by identifying the value of labor and floor space reductions. Finally, we computed three financial measures for each alternative: net present value, internal rate of return, and discounted payback period. Net present value is a measure of the worth of a particular investment in current dollars; internal rate of return is a measure of the return that investment provides; and discounted payback

[3]The FTE calculations also include 14.3 percent additional manpower to fill in for vacations and absences. That 14.3 percent is the current value of fill-in required to support vacations and absences.

period is a measure of the time required to pay for the investment with the savings it will provide over time.

Table 3-3 shows the costs, annual dollar savings, FTE employee reductions, net present value, discounted payback period, and internal rate of return, for each alternative. In all cases, the investments are good ones. The net present values are positive numbers (all are more than $1 million); the internal rates of return are very high (all are more than 100 percent); and the discounted payback periods are all less than 1 year. The resulting FTE employee reductions range from 5.9 in Alternative 1 to 13.8 in Alternative 6. The costs range from $88,000 in Alternative 1 to $414,000 in Alternative 6. In general, the more improvements that an alternative incorporates, the larger the FTE employee reduction.

TABLE 3-3

SUMMARY OF RESULTS

Measure	Alternative					
	1	2	3	4	5	6
Costs (dollars)	$87,500	$125,900	$292,820	$208,720	$247,120	$414,040
Annual savings (dollars)	$250,804	$353,360	$448,589	$367,391	$469,946	$565,176
FTE employee reduction	5.9	8.5	10.9	8.8	11.4	13.8
Net present value	$1,088,889	$1,536,762	$2,083,907	$1,675,605	$2,123,478	$2,670,623
Discounted payback period (years)	0.37	0.38	0.70	0.60	0.56	0.78
Internal rate of return	286%	280%	152%	175%	189%	135%

Note: Net present value and discounted payback calculations use 8 percent cost of capital; they also use a 5-year planning horizon.

Table 3-4 shows the impact of each of the four improvements incorporated in various combinations in our alternatives. The biggest improvement, placed in all of the alternatives, is the use of the new conceptual layout with one pick line and items split into low- and high-activity areas. That improvement yields a reduction of 5.9 FTE employees, a net present value of $1.1 million, a discounted payback period of 0.4 year, and an internal rate of return of 286 percent.

The remaining three improvements are similar in terms of their effects on staffing requirements. The second biggest improvement is the use of carousels and batch picking for low-activity items. It yields a reduction of 2.9 FTE employees, a net

TABLE 3-4

IMPACT OF IMPROVEMENTS

Measure	New layout/ split items	Carousels	Flow racks	Light aids
Costs (dollars)	$87,500	$121,220	$38,400	$166,920
Annual savings (dollars)	$250,804	$116,586	$102,555	$95,230
FTE employee reduction	5.9	2.9	2.6	2.4
Net present value	$1,088,889	$586,716	$447,873	$547,145
Discounted payback period (years)	0.37	1.13	0.40	1.96
Internal rate of return	286%	93%	267%	49%

Note: Net present value and discounted payback calculations use 8 percent cost of capital; they also use a 5-year planning horizon.

present value of $587,000, an internal rate of return of 93 percent and a discounted payback period of 1.1 years. The third biggest improvement is the use of flow racks to store high-activity items. It yields a reduction of 2.6 FTE employees, a net present value of $448,000, a discounted payback period of 0.4 year, and an internal rate of return of 267 percent. The last improvement is the use of light picking aids on the gravity-flow rack that show the picker how much to pick. That improvement will result in an FTE employee reduction of 2.4, a net present value of $547,000, a discounted payback of 2.0 years, and an internal rate of return of 49 percent. All of the improvements show favorable results and combined (Alternative 6) will yield a reduction of 13.8 FTE employees.

Appendix A shows our results in detail, including the data we used, resulting productivity, zones required, manpower allocations, equipment costs, and financial value of each component improvement in each alternative.

SENSITIVITY OF RESULTS

We conducted a sensitivity analysis on productivity improvement factors, costs, and floor space savings to determine how our results might change if those data elements changed. We analyzed our alternatives using a "worst case" and a "best case" set of parameters. The worst case represents what we believe to be the most unfavorable set of circumstances that could occur and similarly the best case

represents the most favorable set of circumstances. Table 3-5 shows the parameters used in our sensitivity analysis. Note that the "expected case" represents the set of parameters used above.

TABLE 3-5

SENSITIVITY ANALYSIS PARAMETERS

Parameter	Expected case	Worst case	Best case
Increase in high-activity item pick rates resulting from separating those items from low-activity items	30%	15%	45%
Increase in pick rates caused by using gravity-flow storage racks	50%	25%	75%
Increase in pick rates caused by using light aids on gravity-flow racks	100%	50%	150%
Decrease in low-activity item pick rates resulting from separating those items from high-activity items	30%	45%	15%
Increase in pick rates caused by using horizontal carousels and batching for low-activity items	150%	75%	225%
Costs			
Rewarehousing for new layout	$9,000	$11,250	$6,750
Power conveyor system	$46,500	$58,125	$34,875
Random case sealer	$32,000	$40,000	$24,000
Carousel equipment	$89,100	$111,375	$66,825
Carousel hardware	$6,000	$7,500	$4,500
Carousel software	$21,000	$26,250	$15,750
Carousel interface	$5,120	$6,400	$3,840
Gravity-flow racks	$38,400	$48,000	$28,800
Light picking equipment	$76,800	$96,000	$57,600
Light picking software	$75,000	$93,750	$56,250
Light picking hardware	$10,000	$12,500	$7,500
Light picking interface	$5,120	$6,400	$3,840
Floor space savings (square feet)	5,000	0	10,000

Table 3-6 shows the results of our sensitivity analysis. All of the alternatives remain favorable ones in the worst case. They all have positive net present values (all are greater than $500,000), low discounted payback periods (all are less than 2 years), and high internal rates of return (all exceed 70 percent). The worst case

FTE employee reductions range from 3.6 in Alternative 1 to 10.8 in Alternative 6. In the best case, the FTE employee reductions range from 7.6 in Alternative 1 to 15.2 in Alternative 6.

TABLE 3-6

SENSITIVITY OF RESULTS

Measure	Case	Alternatives					
		1	2	3	4	5	6
FTE employee reduction	Best	7.6	10.5	12.7	10.2	13.0	15.2
	Expected	5.9	8.5	10.9	8.8	11.4	13.8
	Worst	3.6	5.4	7.7	6.7	8.6	10.8
Net present value	Best	$1,389,898	$1,869,246	$2,347,569	$1,888,894	$2,368,243	$2,846,566
	Expected	$1,088,889	$1,536,762	$2,083,907	$1,675,605	$2,123,478	$2,670,623
	Worst	$682,383	$1,027,950	$1,596,813	$1,335,211	$1,680,778	$2,249,641
Discounted payback period (years)	Best	0.21	0.22	0.44	0.38	0.36	0.52
	Expected	0.37	0.38	0.70	0.60	0.56	0.78
	Worst	0.82	0.77	1.30	1.05	0.97	1.30
Internal rate of return	Best	505%	471%	242%	277%	295%	204%
	Expected	286%	280%	152%	175%	189%	135%
	Worst	129%	137%	80%	100%	108%	79%

Note: Net present value and discounted payback calculations use 8 percent cost of capital; they also use a 5-year planning horizon.

Table 3-7 shows the results of our sensitivity analysis when applied to each individual component improvement in our alternatives. As with the expected case, the worst case analysis shows that the biggest impact is from the improvement incorporating the use of the new conceptual layout with one pick line and items split into low- and high-activity areas. It yields an FTE employee reduction of 3.6. The next biggest improvement is from the use of carousels and batch picking for low-activity items with an FTE reduction of 3.1. The use of flow racks and light picking aids for them will result in an FTE employee reduction of 1.9 and 2.2, respectively, in the worst case. All worst case improvements showed favorable financial measures. The best case improvements yielded FTE employee reductions of 7.6 for the new layout, 2.5 for use of carousels with batch picking, 2.8 for use of flow racks, and 2.2 for use of light aids on the flow racks. Appendix A shows complete results for the worst, expected, and best cases.

TABLE 3-7

SENSITIVITY OF IMPROVEMENTS

Measure	Case	Improvement			
		New layout/ split items	Carousels	Flow racks	Light aids
FTE employee reduction	Best	7.6	2.5	2.8	2.2
	Expected	5.9	2.9	2.6	2.4
	Worst	3.6	3.1	1.9	2.2
Net present value	Best	$1,389,898	$498,997	$479,349	$478,323
	Expected	$1,088,889	$586,716	$447,873	$547,145
	Worst	$682,383	$652,828	$345,567	$568,863
Discounted payback period (years)	Best	0.21	0.96	0.27	1.56
	Expected	0.37	1.13	0.40	1.96
	Worst	0.82	1.32	0.69	2.66
Internal rate of return	Best	505%	110%	392%	65%
	Expected	286%	93%	267%	49%
	Worst	129%	78%	154%	33%

Note: Net present value and discounted payback calculations use 8 percent cost of capital; they also use a 5-year planning horizon.

CONCLUSIONS FROM ALTERNATIVES ANALYSIS

Our analysis helped us to understand the effects of various productivity improvements on labor requirements and the financial value of making those improvements. We have drawn four key conclusions from the analysis. First, *the current warehouse layout and picking methods are inefficient.* All of the alternatives we analyzed will produce cost-effective reductions in FTE employees. Those reductions range from 5.9 employees per MDC for adopting the conceptual layout and splitting the high- and low-activity items (Alternative 1) to 13.8 for adding carousels and light aided flow rack picking to that conceptual layout (Alternative 6).

Second, *within each alternative, all improvements are cost-efficient ones.* The biggest impact will come from adopting the conceptual layout of one line and separate low- and high-activity pick areas. That improvement will result in an FTE reduction of 5.9 employees. The use of carousels, flow racks, and light aids on the flow racks will result in cost-efficient FTE reductions of 2.9, 2.6, and 2.4 employees, respectively.

Third, *the cost of labor at the MDCs is high.* The average employee is paid more than $40,000 when benefits are included. That wage is high for warehouse work and as a consequence makes all of the improvements we investigated look favorable. High investments in technology that can increase labor productivity make sense at the MDCs because of their high labor rates.

Finally, *our results are insensitive to changes in expected productivity improvements and equipment costs.* We found all alternatives and all improvements to be cost-efficient, even in our worst case analysis. The sensitivity analysis revealed that the range of FTE reductions possible at each MDC is between 3.6 and 7.6 employees for adopting the conceptual layout and between 10.8 and 15.2 employees for adopting all of the improvements analyzed. Dramatic improvements are possible, even under worse than expected conditions.

CHAPTER 4

RECOMMENDATIONS

Our analysis has uncovered improvements that can dramatically increase the labor productivity of loose-issue, supply-picking operations at the Somerville and Topeka MDCs while maintaining or improving service levels to customers. In this chapter, we recommend improvements to the layout and pick process, adoption of standard packaging, and pursuit of systems improvements. We also propose a process for configuring the new layout and recommend some management practices that should be followed once that layout becomes operational.

SUPPLY PICK LINE CHANGES

We believe USPS Materiel Distribution should adopt a layout at each MDC incorporating one pick line of four high-activity pick zones, two low-activity pick zones, and one very-low-activity pick zone.[1] Each high-activity pick zone should contain six sections of flow rack 5 feet high by 5 feet wide by 10 feet deep. Those sections will provide enough storage for 192 slots of 10 cubic feet each. The high-activity zones should contain pallets of product directly behind the flow racks for the very active (AA) items. Replenishments from the bulk areas should occur on an average of once every 4 weeks for these items. There are a total of 341 high-activity items.

The high-activity item flow racks should be equipped with light picking aids showing the quantity of each item to be picked for a particular order. Software and workstations are needed to drive these light aids. Also, order labels with bar coded order identification numbers will have to be attached to order cartons in advance of picking so that each picker can scan the bar code as input to the computer-controlled pick software.

The low-activity pick zones should each contain three horizontal carousels with 36 carriers that are 6 feet high by 21.5 inches wide by 18 inches deep. Those

[1]The alternatives analysis revealed that 1.2 low-activity and 3.7 high-activity zones are needed. We have rounded those numbers up to 2 and 4 zones, respectively.

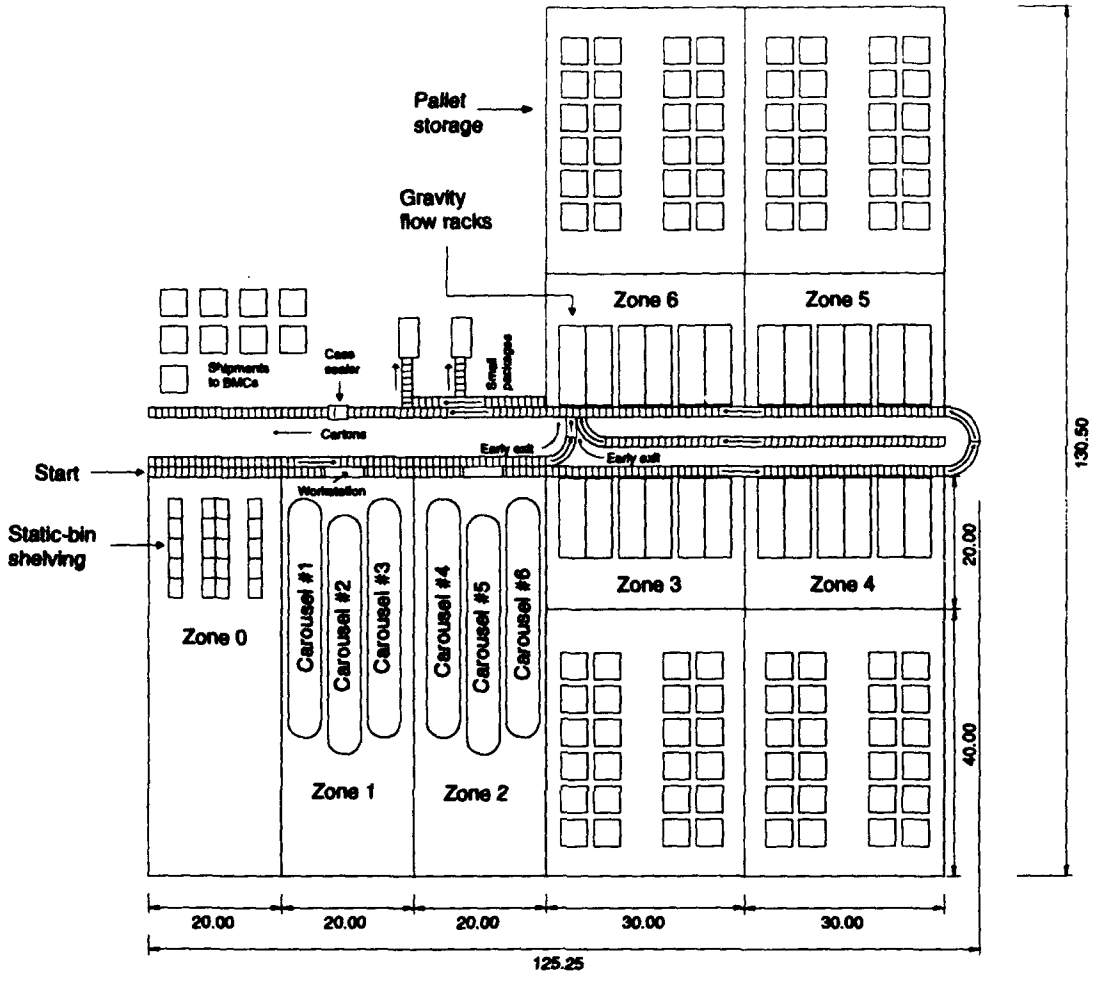
carousels will be controlled by software capable of batching orders as they are scanned into the system by the picker. The picker can then pick in groups of 8 or 10 orders at a time. We suggest that the low-activity item picking precede the high-activity item picking and that orders having only high-activity item picks be sent to the high-activity zones directly without passing through the carousel picking areas. There are a total of 2,147 low-activity items, and they should be replenished from bulk stock every 12 weeks.

The very-low-activity pick zone should contain static-bin shelving arranged so that locations are relatively small. No personnel are needed in this area most of the time since the items in it will have little or no demand. Any picks occurring here should be identified on a preprinted pick list, and those picks should be done prior to the zone picking in the low- and high-activity item areas. There are a total of 149 very-low-activity items.

Figure 4-1 shows our suggested layout. Orders follow the line in a counterclockwise rotation starting at the very-low-activity item pick areas and ending at the pack operation. Orders should be picked sequentially by zone in a pick-and-pass fashion to eliminate the need for consolidation. The new line contains an early exit for orders completed before they have traveled through all zones. A trash conveyor can be located directly above the early exit conveyor for easy removal of empty cartons and other waste items. The pack operation should be automated as much as possible and should utilize a random case sealer for most outgoing containers. Packing should be treated as another zone on the pick line. Our layout shows two pack stations to be used for packing orders into envelopes or jiffy bags – this part of the packing process can also be automated at a later stage. By adopting this improved layout and process, we believe USPS Materiel Distribution can ultimately reduce supply pick line staffing at each MDC from 24 to between 9 and 13 FTE employees.

STANDARD PACKAGING

Although we offer no quantitative analysis of standard packaging, we believe that USPS Materiel Distribution should adopt standard package issue sizes and should require that its vendors provide their products in packages corresponding to those sizes. The goal should be to adopt package sizes that are convenient for both the customers (the post offices) and the warehouse staff. In many cases, customers order



Notes: (1) *All dimensions are in feet.* (2) *Drawing is to scale.* (3) BMC = Bulk materiel center.

FIG. 4-1. PROPOSED USPS SUPPLY ITEM PICK LINE LAYOUT

forms in batches of 50 or 100, but those batches differ from one customer to another. Standardizing those batches will improve pick productivity and prevent inaccuracies from developing over time as a result of pinch picking. It may also aid the pack process in cases in which only one item is ordered and it is prepackaged by the vendor. Without standard packaging, the MDC can never have system-controlled replenishments of loose-issue pick stock because of inaccurate inventory balances.

We do not believe that a standard packaging requirement will add significant cost to the product. Most of the products are forms or other paper products and consequently do not cost much; however, the vendor's cost for providing inner packs is also inexpensive if the vendor uses automated shrink-wrap machines. The real cost in pursuing this strategy is the time USPS personnel will spend to determine standard package sizes and to follow up with vendors to make the necessary changes.

SYSTEMS IMPROVEMENTS

To support the revised layout, we believe that USPS Materiel Distribution should pursue systems support changes in the current system and the use of a locally managed system for controlling warehouse picking and recording item balances by location. We recommend the following changes to the current system:

- Write, test, and put into production a software interface program to produce a file of daily (or twice daily) orders, in American Standard Code for Information Interchange format, containing a customer number, shipping address, items and quantities ordered, and bin locations. That information should then be downloaded daily (or more often) to the file server running software for controlling light-aided, flow-rack picking and carousel picking. This interface program is essential for achieving the improvements associated with light picking on flow racks and batch picking on carousels.

- Continue to produce pick lists and labels for orders but revise the program to print the new zones on each list and label from which an order must be picked. Those lists and labels should contain a bar coded order identification number that can be scanned at each pick zone. The program should sort pick forms by starting zone and should separate one-line picks from multiple-line picks so the former can be processed first. Pick lists and labels should be printed on one form containing both.[2] Because only one pick line is used, the three-line format of the old program must be converted to one that recognizes only one line.

- Revise the processing schedule so that all pick forms are produced and ready for the pickers by 7:30 a.m. at each MDC. The interface programs and corresponding data downloads should also be complete by 7:30 a.m. That schedule will allow the pickers to begin picking current orders at the beginning of their shift instead of at 10:30 or 11:00 a.m.

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[2]At the time of our MDC visits, the Topeka site was already printing labels and lists on one form, but the Somerville site was awaiting new printer hardware before it could combine them.

Adopting the above changes will provide the necessary mainframe systems support needed to make the layout improvements we recommend.

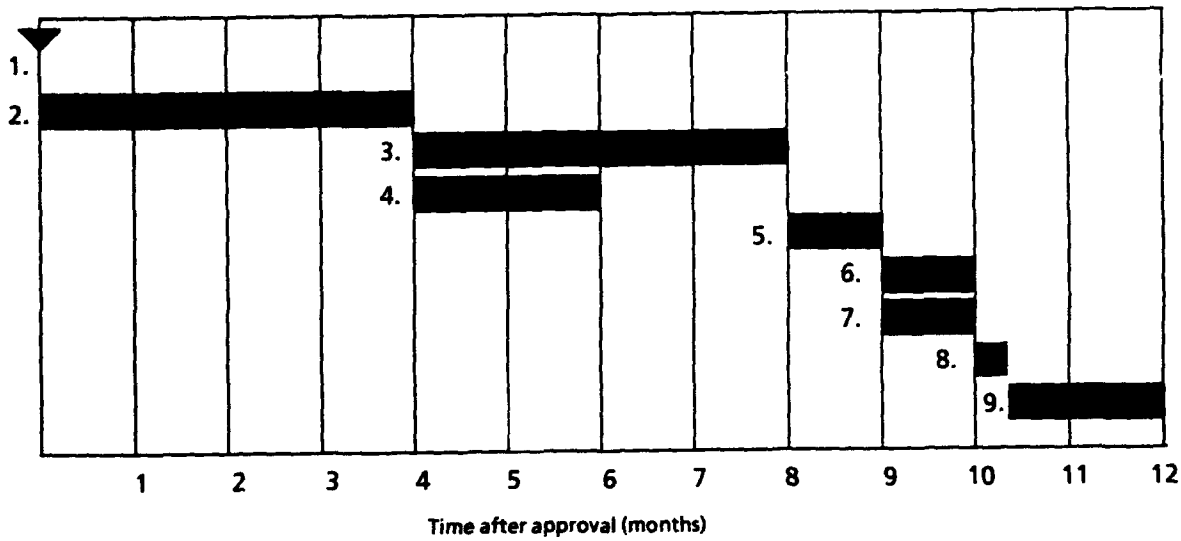
In addition, USPS Materiel Distribution must incorporate the use of a locally controlled PC-based system to drive light picking from flow racks and batch picking from carousels. Initially, we believe this system should be used solely for those purposes and should not contain an item or location data base. The system should consist of a network file server, a workstation in each high- and low-activity zone, and a supervisor workstation. Those stations should be tied together with a local area network. We believe that at some future time, the USPS should pursue the addition of an item and location data base to this system, and that data base should be capable of tracking item balances by location and valuable location cube information. Weight and cube information could be added to this system and used for planning shipping carton sizes in advance and in planning locations for items. The software should also provide USPS Materiel Distribution management with individual performance productivity data. That type of software is available, for the most part, directly off the shelf with little or no tailoring by material-handling vendors. We believe, however, that USPS will need one person on site at each MDC to ensure the smooth operation of the locally controlled software and hardware.

THE RECONFIGURATION PROCESS

The process of reconfiguring each MDC to conform to our recommended layout should take a maximum of 1 year from the time approval is obtained. Figure 4-2 shows a schedule and suggested action plan for managing this effort. The activities in that action plan are:

- *Capital budgeting process and project approval* – Our analysis indicates that funding of $414,000 will be required for each MDC to purchase 300 linear feet of power-roller conveyor, a random case sealer, six 36-carrier horizontal carousels, 4,320 cubic feet of flow rack, 384 light picking aids, software for carousel batch picking and light picking, and computer hardware. Also included in that funding is $9,000 for labor associated with the rewarehousing effort that will be required and $10,240 for labor associated with mainframe interface programming.

- *Item analysis and detailed design specifications* – The recommendations in this report must be refined so that exact specifications can be issued to vendors providing material-handling equipment. Items must be examined one by one to determine the exact amount of space needed for each, and corresponding modifications to the suggested equipment amounts must then



Activity
1. Project approval
2. Item analysis and detailed design specifications
3. Procurement process
   a. Conveyance systems
   b. Flow racks
   c. Carousels
   d. Light systems
   e. Software
   f. Computer hardware
4. Mainframe computer interface and program changes
5. Installation and testing of equipment
6. Planning of rewarehousing
7. Training
8. Rewarehousing of items
9. System startup.

FIG. 4-2. SUGGESTED ACTION PLAN

be made before the vendor solicitation process begins. All plans should be agreed upon by management, supervisory and (even) hourly personnel involved in running the operations at the MDCs. We anticipate this process taking up to 4 months to complete.

- *Procurement process* – The actual procurement process should consist of issuing design specifications to vendors, evaluating their proposals, and procuring the required equipment. Vendor proposals should be evaluated on the basis of price and on the basis of delivery time, quality and reliability of equipment, service guarantees, confidence in the vendor's ability to deliver, and other concerns. The awards should be made on the basis of best value to the USPS. We anticipate that the entire procurement process could be completed in a total of 4 months; 1 month for solicitation and review of bids and 3 months material-handling equipment procurement lead time.

- *Mainframe computer interface and program changes* – The systems support staff must provide a data file to be downloaded daily for use by the locally controlled PC-based software. In addition, we identified above some minor changes that are needed in programs and scheduling. Our recommended approach does not require extensive effort on the part of the systems support staff but rather relies heavily on locally controlled software to provide systems-related functions. We anticipate that this activity should be completed in no more than 2 months.

- *Installation and testing of equipment* – Once the required equipment and software arrive, they must be installed and tested to ensure they operate properly. Vendors or their designees are usually responsible for this testing, and it should be part of any contract awarded to them. The USPS should request that some portion of payments to the vendor be withheld until it approves the installation. Those sign-offs should not occur until USPS has tested the equipment thoroughly and is satisfied with it. Some portion of payment should also be withheld until after the equipment has been operating for some prespecified period of time to ensure that the vendor addresses problems that occur in a timely manner. We anticipate the installation and testing activity to take 1 month to complete.

- *Planning rewarehousing* – Before moving products into the new storage equipment, the MDC staff must determine the exact sizes of locations in that equipment, the quantity of each size location required, and the actual location that each item will occupy in the new layout. The staff must also develop a plan to rewarehouse the items in such a way as to minimize the interruption to daily operations. Our schedule allows 1 month for this activity.

- *Training* – Both direct and indirect personnel must be trained to make the reconfigured facility layout operate effectively. Pickers, packers, and other system users must be shown the new operating procedures at each type of workstation in the system. A few persons, including lead workers and supervisory personnel, must be trained in the use of the workstations to download orders from the mainframe computer and to control the flow of work to each workstation. For maximum retention, we recommend conducting this training as close as possible to the actual startup date. We also recommend having training staff available after startup to help with questions and problems that will occur. Our schedule allows 1 month for this activity.

- *Rewarehousing of items* – Items must be moved from old locations to new locations, preferably on a weekend or at night. Extra staffing or overtime will be required to handle this labor demand. We have allotted 2 days for this effort.

- *System startup* – Once items are rewarehoused and employees are trained, the new system is ready for operation.

To manage the reconfiguration process USPS will need, at a minimum, a project team consisting of a project leader and two team members devoted to detailed layout and planning issues. Other team members should include facility maintenance personnel, pick-line supervisors, and pick-line employees.

MANAGING THE NEW SYSTEM

Once system startup is completed, USPS will need to focus on achieving the goals of the reconfiguration. To keep the project focused, we recommend that productivity and service improvement goals be established and monitored over time. We also recommend that the reconfiguration project team devote its efforts to identifying and fixing problems in the new system that prevent USPS from reaching the agreed upon productivity and service goals. For a time after initial system startup, productivity will probably decrease because the work force is not fully competent with the new style of business and because unforeseen equipment and software problems will surface. The project team needs to address those items for several months after system startup to ensure that overall project goals are met.

The new reconfiguration will require some local expertise to manage the PC network and the software used to feed pick instructions to the workstations. This will not be a full-time position but will require a designated individual to ensure that orders are downloaded daily, that all hardware is operational, and that software is functioning properly.

SUMMARY

USPS Materiel Distribution should reconfigure its MDC supply item pick lines into one line at each MDC with four high-activity and two low-activity pick zones. The high-activity items should be stored in gravity-flow racks with light-picking devices attached. The very-high-activity items should have backup stock on pallets behind the gravity-flow racks. The low-activity items should be stored in horizontal carousels controlled by software capable of batching orders. For the majority of orders, packing should be accomplished by a random case sealer embedded into the completed order-take-away conveyor.

The process of reconfiguring the pick lines should take a maximum of 1 year and should be managed by a project team composed of staff and line personnel at the MDCs. That project team should measure the performance of the reconfiguration after startup and should address unforeseen events that affect overall performance. The reconfigured pick lines will, over time, allow the MDCs to operate their supply pick-line operations with between 9 and 13 FTE employees, compared to 24 FTE employees today.

CHAPTER 5

COMBINING MATERIEL DISTRIBUTION CENTER OPERATIONS AND REPAIR PART PICKING IMPROVEMENTS

Although the primary focus of our study was the individual MDC supply pick lines, we were asked, during the course of our study, to examine two related topics: combining the Topeka and Somerville supply pick line operations and improving the repair part pick lines at Topeka. We investigated both topics, and in this chapter, we present some of our conclusions about them.

COMBINING MATERIEL DISTRIBUTION CENTER OPERATIONS

Combining the supply pick line operations of the Somerville and Topeka MDCs will not result in any direct labor savings. The results of our supply pick line analysis can easily be applied to a combined operation that would have twice as many zones, twice as much floor space, and twice as much product or it can be applied to one of the same size that is replenished twice as often and operates on two shifts daily instead of one. Either way, the required amount of direct labor is the same.

The warehouse related savings come from the indirect labor associated with systems support, accounting, management, etc. We do not have access to those data, but USPS Materiel Distribution management can determine the exact value of the savings.

The USPS must consider a number of other major costs carefully before combining MDC supply operations. Combining facilities will have the following result:

- A *decrease* in inventory and the costs associated with holding that inventory
- An *increase* in the cost of transporting products to some customers
- Both *increases and decreases* in inbound freight costs
- An *increase* in time to transport items to some customers.

We believe that these factors, not warehouse savings, should ultimately drive the decision to combine MDC operations.

REPAIR PART PICKING IMPROVEMENTS

We observed the repair part picking operation in Topeka and found that the lines contained a large amount of relatively slow-moving products. The bin locations were various sizes and were packed nearly full in many cases. We calculated that those parts are using 18,000 cubic feet of bin space on the A–K and L–Z lines (the two major lines). Those pick lines contain 8,000 different items and have 1,400 item lines demanded per day. The pick job requires some weight counts and a very significant amount of walking time. We observed 12 employees working in the repair part picking-and-packing areas. Total productivity is on the order of 15 lines an hour including the pack-and-replenishment activities. For an operation of this type with manual bin picking, we believe that productivity to be about average.

We believe productivity improvements would be possible if horizontal carousels were used to store these items and software capable of batch picking were used to control the pick process. The items in the repair parts area are, in many ways, similar to the low-volume items in the supply pick area. Manual picking of those items results in extensive walking from bin to bin and is not productive. The items are not replenished frequently. The major difference from the low-activity supply items is that the amount of cubic volume required to house the repair part items is much larger than for the supply items. We believe 12 to 16 carousels are needed. They can be placed in groups of four with one picker for each group. Our initial estimates indicate that the Topeka repair part pick-line labor could be reduced by about 50 percent using this approach. Approximate costs, however, could be as high as $300,000. A more realistic approach may be to put half of the items in the carousels and leave the remaining (very-low-activity) ones in static-bin shelving.

The MDC staff is considering the use of gravity-flow racks for these items. We believe that gravity-flow racks may be appropriate for large items or items with large on-hand balances. We do not believe it is appropriate for the smaller or lower quantity items because much of the flow rack space will be wasted. This will result in even greater walking time for the pickers and ultimately in a decrease in productivity. The flow racks are only appropriate for high-volume or large items.

As with the supply pick lines, dramatic improvements are possible in terms of productivity, but in terms of actual FTE employee reduction, the savings will be small because only 13 total FTE employees are currently allocated to that area.

APPENDIX

ALTERNATIVES ANALYSIS DETAIL

This appendix presents detailed information about each alternative analyzed in the expected, worst, and best cases. Each alternative applies to one materiel distribution center (they are treated identically). For each of the three cases, we present nine pages with the following information:

- *Input parameters* – This information is used to make the necessary computations. It includes fixed parameters (specific to the United States Postal Service), cost parameters (equipment, software, hardware costs), sensitive parameters (productivity assumptions, a cost escalation factor, a square foot savings factor), and descriptive codes for alternatives analyzed.
- *Productivity model* – This information shows the productivity achieved in each alternative and the number of zones required for those alternatives. It also shows a breakdown of work force requirements and labor savings by alternative.
- *Marginal costs* – These cost figures are used in each alternative by type of improvement. The numbers represent one-time costs that are to be incurred in implementing each alternative.
- *Marginal savings* – This section shows the total labor savings and value of floor space savings associated with each alternative on an annual basis.
- *Financial analysis of alternatives (2 pages)* – This section shows the costs, annual dollar savings, full-time-equivalent (FTE) employee reduction, net present value, discounted payback period, and internal rate of return broken down by improvement for each of the six alternatives.
- *Cash flow streams used* – This page shows the actual cash flow streams used in computing net present value, discounted payback period, and internal rate of return by improvement for each of the six alternatives.
- *Summary of results* – This section summarizes total costs, total annual dollar savings, total FTE employee reduction, total investment net present value, total investment discounted payback period, and total investment internal rate of return for each alternative.

- *Impact of improvements* – Here we show costs, annual dollar savings, FTE employee reduction, net present value, discounted payback period, and internal rate of return for each type of improvement that we analyzed.

We show expected case information first, followed by worst case information, and then best case information.

Enter E, B, or W: E Expected Case

INPUT PARAMETERS

FIXED PARAMETERS

Low Activity Lines	1096
High Activity Lines	4396
Current Pick Rate	60.0
Hrs to Complete Picks	8.0
Utilization Factor	0.875
Fill In Percent	0.143
Fork Lift Drivers - old	1.0
Fork Lift Drivers - new	1.0
Consolidators - old	2.0
Consolidators - new	0.0
No Packers - old layout	4.9
No Packers - new layout	3.0
Annual Employee Cost	40120

COST PARAMETERS

New Layout Rewarehousing	9000
New Layout Conveyor	46500
Random Case Sealer	32000
Carousel Equipment	89100
Carousel Hardware	6000
Carousel Software	21000
Carousel Interface	5120
Flow Racks	38400
Light Picking Equipment	76800
Light Picking Software	75000
Light Picking Hardware	10000
Light Picking Interface	5120

SENSITIVE PARAMETERS	This Case	Worst	Expected	Best
Low Act Split Factor	-30%	-45%	-30%	-15%
Low Act Carous Factor	150%	75%	150%	225%
High Act Split Factor	30%	15%	30%	45%
High Act GFR Factor	50%	25%	50%	75%
High Act Light Factor	100%	50%	100%	150%
Cost Escalation Fact	0%	25%	0%	-25%
SF Savings Fact	0%	-100%	0%	100%

ALTERNATIVES (1=Y,0=N)	Base	1	2	3	4	5	6
low act - split	0	1	1	1	1	1	1
low act - carousels	0	0	0	0	1	1	1
high act - split	0	1	1	1	1	1	1
high act - flow racks	0	0	1	1	0	1	1
high act - lights	0	0	0	1	0	0	1

PRODUCTIVITY MODEL

PRODUCTIVITY/ZONES	Base	Alternative --> 1	2	3	4	5	6
low act - base LPH	60	60	60	60	60	60	60
low act - split	0	-18	-18	-18	-18	-18	-18
low act - carousels	0	0	0	0	90	90	90
high act - base LPH	60	60	60	60	60	60	60
high act - split	0	18	18	18	18	18	18
high act - flow racks	0	0	30	30	0	30	30
high act - lights	0	0	0	60	0	0	60
Low Activity LPH	60.0	42.0	42.0	42.0	132.0	132.0	132.0
High Activity LPH	60.0	78.0	108.0	168.0	78.0	108.0	168.0
Low Activity Hrs	18.3	26.1	26.1	26.1	8.3	8.3	8.3
High Activity Hrs	73.3	56.4	40.7	26.2	56.4	40.7	26.2
Low Activity Zones	2.6	3.7	3.7	3.7	1.2	1.2	1.2
High Activity Zones	10.5	8.1	5.8	3.7	8.1	5.8	3.7
Total Zones	13.1	11.8	9.5	7.5	9.2	7.0	4.9
WORK FORCE REQUIREMENTS							
Pickers	13.1	11.8	9.5	7.5	9.2	7.0	4.9
Consolidators	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Pack/Ship	4.9	3.0	3.0	3.0	3.0	3.0	3.0
Forklift	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Fill In	3.0	2.3	1.9	1.6	1.9	1.6	1.3
Total	24.0	18.0	15.5	13.1	15.1	12.6	10.2
Manpower Savings	0.0	5.9	8.5	10.9	8.8	11.4	13.8
MANPOWER SAVINGS BREAKDOWN (each category includes fill in)							
Due to Realignment	0.0	4.5	4.5	4.5	4.5	4.5	4.5
Due to Low Act Split	-0.0	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3
Due to Low Act Carousels	-0.0	-0.0	-0.0	-0.0	2.9	2.9	2.9
Due to High Act Split	-0.0	2.8	2.8	2.8	2.8	2.8	2.8
Due to High Act GFR	-0.0	-0.0	2.6	2.6	-0.0	2.6	2.6
Due to High Act Lights	-0.0	-0.0	-0.0	2.4	-0.0	-0.0	2.4
Total	-0.0	5.9	8.5	10.9	8.8	11.4	13.8

MARGINAL COSTS

Cost Items	Alternative 1	2	3	4	5	6
New Layout / Split						
rewarehousing of 3000 items	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000
300 ft accumulating power conv	$46,500	$46,500	$46,500	$46,500	$46,500	$46,500
case sealer	$32,000	$32,000	$32,000	$32,000	$32,000	$32,000
Carousels for low activity items						
3483 cubic feet carousel storage	$0	$0	$0	$89,100	$89,100	$89,100
hardware	$0	$0	$0	$6,000	$6,000	$6,000
software	$0	$0	$0	$21,000	$21,000	$21,000
in-house software interface	$0	$0	$0	$5,120	$5,120	$5,120
Gravity Flow Racks for HA items						
4320 cubic feet flow rack storage	$0	$38,400	$38,400	$0	$38,400	$38,400
Light picking for high activity items						
384 lights	$0	$0	$76,800	$0	$0	$76,800
software	$0	$0	$75,000	$0	$0	$75,000
hardware	$0	$0	$10,000	$0	$0	$10,000
in-house software interface	$0	$0	$5,120	$0	$0	$5,120
Costs by Improvement						
New Layout/Split	$87,500	$87,500	$87,500	$87,500	$87,500	$87,500
Carousels for LA items	$0	$0	$0	$121,220	$121,220	$121,220
GFR for HA items	$0	$38,400	$38,400	$0	$38,400	$38,400
Light picking for HA items	$0	$0	$166,920	$0	$0	$166,920
Total	$87,500	$125,900	$292,820	$208,720	$247,120	$414,040

Notes on Calculations:

1. Rewarehousing costs calculated at $30 per hour for 300 hours.
2. Conveyor costs estimated at $50 per linear foot for equipment and $25 per foot for electrical and mechanical systems (400 feet). Also included are 3 drives at $2000 each and seven 90 degree turns at $1500 each.
3. Case sealer cost of $32,000 includes capability to seal random sized cartons.
4. Carousel cost includes six 36 carrier units with carriers 6 feet high by 21.5 inches wide by 18 inches deep. Also includes $15,000 for options.
5. Carousel hardware costs include 3 workstations and 1 server.
6. Carousel software costs include batching and full database capability.
7. In-house software development costs estimated at $32 per man hour. Estimate of 160 hours for carousel interface and 160 hours for gravity flow rack light picking interface used.
8. Flow rack costs estimated at $100 per slot for 384 slots.
9. Gravity flow rack light picking costs estimated at $200 per light plus $75,000 for software control. $10,000 added for computer hardware needed.

MARGINAL SAVINGS

Savings Category	Alternative 1	2	3	4	5	6
5,000 SF Floorspace	$12,500	$12,500	$12,500	$12,500	$12,500	$12,500
Labor Savings	$238,304	$340,860	$436,089	$354,891	$457,446	$552,676
Savings by Improvement						
New Layout / Split	$250,804	$250,804	$250,804	$250,804	$250,804	$250,804
Carousels for LA items	($0)	($0)	($0)	$116,586	$116,586	$116,586
GFR for HA items	($0)	$102,555	$102,555	($0)	$102,555	$102,555
Light picking for HA items	($0)	($0)	$95,230	($0)	($0)	$95,230
Total Savings	$250,804	$353,360	$448,589	$367,391	$469,946	$565,176

Notes on Calculations:

1. Floorspace savings valued at $2.50 per square foot.
2. Currently using 20,000 SF at each MDC. New layout requires 15,000 SF.
3. Labor savings valued at average annual rate of $34,000 per employee plus 18 percent for benefits.

FINANCIAL ANALYSIS OF ALTERNATIVES

Measure	Alternative 1	2	3	4	5	6
Costs by Improvement						
New Layout / Split Items	$87,500	$87,500	$87,500	$87,500	$87,500	$87,500
Carousels for LA items	$0	$0	$0	$121,220	$121,220	$121,220
GFR for HA items	$0	$38,400	$38,400	$0	$38,400	$38,400
Light picking for HA items	$0	$0	$166,920	$0	$0	$166,920
Total	$87,500	$125,900	$292,820	$208,720	$247,120	$414,040
Annual Dollar Savings by Improvement						
New Layout / Split Items	$250,804	$250,804	$250,804	$250,804	$250,804	$250,804
Carousels for LA items	($0)	($0)	($0)	$116,586	$116,586	$116,586
GFR for HA items	($0)	$102,555	$102,555	($0)	$102,555	$102,555
Light picking for HA items	($0)	($0)	$95,230	($0)	($0)	$95,230
Total	$250,804	$353,360	$448,589	$367,391	$469,946	$565,176
FTE Reduction by Improvement						
New Layout / Split Items	5.9	5.9	5.9	5.9	5.9	5.9
Carousels for LA items	0.0	0.0	0.0	2.9	2.9	2.9
GFR for HA items	0.0	2.6	2.6	0.0	2.6	2.6
Light picking for HA items	0.0	0.0	2.4	0.0	0.0	2.4
Total	5.9	8.5	10.9	8.8	11.4	13.8

FINANCIAL ANALYSIS OF ALTERNATIVES (continued)

Measure	Alternative 1	2	3	4	5	6
Net Present Value by Improvement (current dollars)						
New Layout / Split Items	$1,088,889	$1,088,889	$1,088,889	$1,088,889	$1,088,889	$1,088,889
Carousels for LA items	-----	-----	-----	$586,716	$586,716	$586,716
GFR for HA items	-----	$447,873	$447,873	-----	$447,873	$447,873
Light picking for HA items	-----	-----	$547,145	-----	-----	$547,145
Total	$1,088,889	$1,536,762	$2,083,907	$1,675,605	$2,123,478	$2,670,623
Discounted Payback by Improvement (years)						
New Layout / Split Items	0.37	0.37	0.37	0.37	0.37	0.37
Carousels for LA items	----	----	----	1.13	1.13	1.13
GFR for HA items	----	0.40	0.40	----	0.40	0.40
Light picking for HA items	----	----	1.96	----	----	1.96
Total	0.37	0.38	0.70	0.60	0.56	0.78
Discounted Rate of Return by Improvement						
New Layout / Split Items	286%	286%	286%	286%	286%	286%
Carousels for LA items	---	---	---	93%	93%	93%
GFR for HA items	---	267%	267%	---	267%	267%
Light picking for HA items	---	---	49%	---	---	49%
Total	286%	280%	152%	175%	189%	135%

HA = High Activity LA = Low Activity FTE = Full Time Equivalent

Notes on Calculations:

1. Net present value and discounted payback calculations use 8 percent cost of capital. They also use five year planning horizon.

CASH FLOW STREAMS USED

Improvement	Year	Alternative 1	2	3	4	5	6
New Layout / Split	0	($87,500)	($87,500)	($87,500)	($87,500)	($87,500)	($87,500)
	1	$250,804	$250,804	$250,804	$250,804	$250,804	$250,804
	2	$250,804	$250,804	$250,804	$250,804	$250,804	$250,804
	3	$250,804	$250,804	$250,804	$250,804	$250,804	$250,804
	4	$250,804	$250,804	$250,804	$250,804	$250,804	$250,804
	5	$250,804	$250,804	$250,804	$250,804	$250,804	$250,804
Carousels for LA items	0	$0	$0	$0	($121,220)	($121,220)	($121,220)
	1	($0)	($0)	($0)	$116,586	$116,586	$116,586
	2	($0)	($0)	($0)	$116,586	$116,586	$116,586
	3	($0)	($0)	($0)	$116,586	$116,586	$116,586
	4	($0)	($0)	($0)	$116,586	$116,586	$116,586
	5	($0)	($0)	($0)	$116,586	$116,586	$116,586
GFR for HA items	0	$0	($38,400)	($38,400)	$0	($38,400)	($38,400)
	1	($0)	$102,555	$102,555	($0)	$102,555	$102,555
	2	($0)	$102,555	$102,555	($0)	$102,555	$102,555
	3	($0)	$102,555	$102,555	($0)	$102,555	$102,555
	4	($0)	$102,555	$102,555	($0)	$102,555	$102,555
	5	($0)	$102,555	$102,555	($0)	$102,555	$102,555
Light picking for HA items	0	$0	$0	($166,920)	$0	$0	($166,920)
	1	($0)	($0)	$95,230	($0)	($0)	$95,230
	2	($0)	($0)	$95,230	($0)	($0)	$95,230
	3	($0)	($0)	$95,230	($0)	($0)	$95,230
	4	($0)	($0)	$95,230	($0)	($0)	$95,230
	5	($0)	($0)	$95,230	($0)	($0)	$95,230
Total	0	($87,500)	($125,900)	($292,820)	($208,720)	($247,120)	($414,040)
	1	$250,804	$353,360	$448,589	$367,391	$469,946	$565,176
	2	$250,804	$353,360	$448,589	$367,391	$469,946	$565,176
	3	$250,804	$353,360	$448,589	$367,391	$469,946	$565,176
	4	$250,804	$353,360	$448,589	$367,391	$469,946	$565,176
	5	$250,804	$353,360	$448,589	$367,391	$469,946	$565,176

SUMMARY OF RESULTS Expected Case

Measure	Alternative 1	2	3	4	5	6
Costs (dollars)	$87,500	$125,900	$292,820	$208,720	$247,120	$414,040
Annual Savings (dollars)	$250,804	$353,360	$448,589	$367,391	$469,946	$565,176
FTE Reduction	5.9	8.5	10.9	8.8	11.4	13.8
Net Present Value	$1,088,889	$1,536,762	$2,083,907	$1,675,605	$2,123,478	$2,670,623
Discounted Payback Period (years)	0.37	0.38	0.70	0.60	0.56	0.78
Internal Rate of Return	286%	280%	152%	175%	189%	135%

FTE = Full Time Equivalent

Notes on Calculations:

1. Net present value and discounted payback calculations use 8 percent cost of capital. They also use five year planning horizon.

IMPACT OF IMPROVEMENTS

Measure	New Layout/ Split Items	Carou-sels	Flow Racks	Light Aids
Costs (dollars)	$87,500	$121,220	$38,400	$166,920
Annual Savings (dollars)	$250,804	$116,586	$102,555	$95,230
FTE Reduction	5.9	2.9	2.6	2.4
Net Present Value	$1,088,889	$586,716	$447,873	$547,145
Discounted Payback Period (years)	0.37	1.13	0.40	1.96
Internal Rate of Return	286%	93%	267%	49%

FTE = Full Time Equivalent

Notes on Calculations:

1. Net present value and discounted payback calculations use 8 percent cost of capital. They also use five year planning horizon.

Enter E, B, or W: W Worst Case

INPUT PARAMETERS

FIXED PARAMETERS

Low Activity Lines	1096
High Activity Lines	4396
Current Pick Rate	60.0
Hrs to Complete Picks	8.0
Utilization Factor	0.875
Fill In Percent	0.143
Fork Lift Drivers - old	1.0
Fork Lift Drivers - new	1.0
Consolidators - old	2.0
Consolidators - new	0.0
No Packers - old layout	4.9
No Packers - new layout	3.0
Annual Employee Cost	40120

COST PARAMETERS

New Layout Rewarehousing	9000
New Layout Conveyor	46500
Random Case Sealer	32000
Carousel Equipment	89100
Carousel Hardware	6000
Carousel Software	21000
Carousel Interface	5120
Flow Racks	38400
Light Picking Equipment	76800
Light Picking Software	75000
Light Picking Hardware	10000
Light Picking Interface	5120

SENSITIVE PARAMETERS	This Case	Worst	Expected	Best
Low Act Split Factor	-45%	-45%	-30%	-15%
Low Act Carous Factor	75%	75%	150%	225%
High Act Split Factor	15%	15%	30%	45%
High Act GFR Factor	25%	25%	50%	75%
High Act Light Factor	50%	50%	100%	150%
Cost Escalation Fact	25%	25%	0%	-25%
SF Savings Fact	-100%	-100%	0%	100%

ALTERNATIVES (1=Y,0=N)	Base	1	2	3	4	5	6
low act - split	0	1	1	1	1	1	1
low act - carousels	0	0	0	0	1	1	1
high act - split	0	1	1	1	1	1	1
high act - flow racks	0	0	1	1	0	1	1
high act - lights	0	0	0	1	0	0	1

PRODUCTIVITY MODEL

		Alternative -->					
PRODUCTIVITY/ZONES	Base	1	2	3	4	5	6
low act - base LPH	60	60	60	60	60	60	60
low act - split	0	-27	-27	-27	-27	-27	-27
low act - carousels	0	0	0	0	45	45	45
high act - base LPH	60	60	60	60	60	60	60
high act - split	0	9	9	9	9	9	9
high act - flow racks	0	0	15	15	0	15	15
high act - lights	0	0	0	30	0	0	30
Low Activity LPH	60.0	33.0	33.0	33.0	78.0	78.0	78.0
High Activity LPH	60.0	69.0	84.0	114.0	69.0	84.0	114.0
Low Activity Hrs	18.3	33.2	33.2	33.2	14.1	14.1	14.1
High Activity Hrs	73.3	63.7	52.3	38.6	63.7	52.3	38.6
Low Activity Zones	2.6	4.7	4.7	4.7	2.0	2.0	2.0
High Activity Zones	10.5	9.1	7.5	5.5	9.1	7.5	5.5
Total Zones	13.1	13.8	12.2	10.3	11.1	9.5	7.5
WORK FORCE REQUIREMENTS							
Pickers	13.1	13.8	12.2	10.3	11.1	9.5	7.5
Consolidators	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Pack/Ship	4.9	3.0	3.0	3.0	3.0	3.0	3.0
Forklift	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Fill In	3.0	2.6	2.3	2.0	2.2	1.9	1.6
Total	24.0	20.4	18.5	16.3	17.3	15.4	13.2
Manpower Savings	0.0	3.6	5.4	7.7	6.7	8.6	10.8
MANPOWER SAVINGS BREAKDOWN (each category includes fill in)							
Due to Realignment	0.0	4.5	4.5	4.5	4.5	4.5	4.5
Due to Low Act Split	-0.0	-2.4	-2.4	-2.4	-2.4	-2.4	-2.4
Due to Low Act Carousels	-0.0	0.0	0.0	0.0	3.1	3.1	3.1
Due to High Act Split	-0.0	1.6	1.6	1.6	1.6	1.6	1.6
Due to High Act GFR	-0.0	0.0	1.9	1.9	0.0	1.9	1.9
Due to High Act Lights	-0.0	0.0	-0.0	2.2	0.0	-0.0	2.2
Total	-0.0	3.6	5.4	7.7	6.7	8.6	10.8

MARGINAL COSTS

Cost Items	Alternative 1	2	3	4	5	6
New Layout / Split						
rewarehousing of 3000 items	$11,250	$11,250	$11,250	$11,250	$11,250	$11,250
300 ft accumulating power conv	$58,125	$58,125	$58,125	$58,125	$58,125	$58,125
case sealer	$40,000	$40,000	$40,000	$40,000	$40,000	$40,000
Carousels for low activity items						
3483 cubic feet carousel storage	$0	$0	$0	$111,375	$111,375	$111,375
hardware	$0	$0	$0	$7,500	$7,500	$7,500
software	$0	$0	$0	$26,250	$26,250	$26,250
in-house software interface	$0	$0	$0	$6,400	$6,400	$6,400
Gravity Flow Racks for HA items						
4320 cubic feet flow rack storage	$0	$48,000	$48,000	$0	$48,000	$48,000
Light picking for high activity items						
384 lights	$0	$0	$96,000	$0	$0	$96,000
software	$0	$0	$93,750	$0	$0	$93,750
hardware	$0	$0	$12,500	$0	$0	$12,500
in-house software interface	$0	$0	$6,400	$0	$0	$6,400
Costs by Improvement						
New Layout/Split	$109,375	$109,375	$109,375	$109,375	$109,375	$109,375
Carousels for LA items	$0	$0	$0	$151,525	$151,525	$151,525
GFR for HA items	$0	$48,000	$48,000	$0	$48,000	$48,000
Light picking for HA items	$0	$0	$208,650	$0	$0	$208,650
Total	$109,375	$157,375	$366,025	$260,900	$308,900	$517,550

Notes on Calculations:

1. Rewarehousing costs calculated at $30 per hour for 300 hours.
2. Conveyor costs estimated at $50 per linear foot for equipment and $25 per foot for electrical and mechanical systems (400 feet). Also included are 3 drives at $2000 each and seven 90 degree turns at $1500 each.
3. Case sealer cost of $32,000 includes capability to seal random sized cartons.
4. Carousel cost includes six 36 carrier units with carriers 6 feet high by 21.5 inches wide by 18 inches deep. Also includes $15,000 for options.
5. Carousel hardware costs include 3 workstations and 1 server.
6. Carousel software costs include batching and full database capability.
7. In-house software development costs estimated at $32 per man hour. Estimate of 160 hours for carousel interface and 160 hours for gravity flow rack light picking interface used.
8. Flow rack costs estimated at $100 per slot for 384 slots.
9. Gravity flow rack light picking costs estimated at $200 per light plus $75,000 for software control. $10,000 added for computer hardware needed.

MARGINAL SAVINGS

Savings Category	Alternative 1	2	3	4	5	6
5,000 SF Floorspace	$0	$0	$0	$0	$0	$0
Labor Savings	$143,514	$218,041	$308,259	$269,068	$343,596	$433,813
Savings by Improvement						
New Layout / Split	$143,514	$143,514	$143,514	$143,514	$143,514	$143,514
Carousels for LA items	$0	$0	$0	$125,555	$125,555	$125,555
GFR for HA items	$0	$74,528	$74,528	$0	$74,528	$74,528
Light picking for HA items	$0	($0)	$90,218	$0	($0)	$90,218
Total Savings	$143,514	$218,041	$308,259	$269,068	$343,596	$433,813

Notes on Calculations:

1. Floorspace savings valued at $2.50 per square foot.
2. Currently using 20,000 SF at each MDC. New layout requires 15,000 SF.
3. Labor savings valued at average annual rate of $34,000 per employee plus 18 percent for benefits.

FINANCIAL ANALYSIS OF ALTERNATIVES

	********** Alternative **********					
Measure	1	2	3	4	5	6
Costs by Improvement						
New Layout / Split Items	$109,375	$109,375	$109,375	$109,375	$109,375	$109,375
Carousels for LA items	$0	$0	$0	$151,525	$151,525	$151,525
GFR for HA items	$0	$48,000	$48,000	$0	$48,000	$48,000
Light picking for HA items	$0	$0	$208,650	$0	$0	$208,650
Total	$109,375	$157,375	$366,025	$260,900	$308,900	$517,550
Annual Dollar Savings by Improvement						
New Layout / Split Items	$143,514	$143,514	$143,514	$143,514	$143,514	$143,514
Carousels for LA items	$0	$0	$0	$125,555	$125,555	$125,555
GFR for HA items	$0	$74,528	$74,528	$0	$74,528	$74,528
Light picking for HA items	$0	($0)	$90,218	$0	($0)	$90,218
Total	$143,514	$218,041	$308,259	$269,068	$343,596	$433,813
FTE Reduction by Improvement						
New Layout / Split Items	3.6	3.6	3.6	3.6	3.6	3.6
Carousels for LA items	0.0	0.0	0.0	3.1	3.1	3.1
GFR for HA items	0.0	1.9	1.9	0.0	1.9	1.9
Light picking for HA items	0.0	0.0	2.2	0.0	0.0	2.2
Total	3.6	5.4	7.7	6.7	8.6	10.8

FINANCIAL ANALYSIS OF ALTERNATIVES (continued)

	********** Alternative **********					
Measure	1	2	3	4	5	6
Net Present Value by Improvement (current dollars)						
New Layout / Split Items	$682,383	$682,383	$682,383	$682,383	$682,383	$682,383
Carousels for LA items	-----	-----	-----	$652,828	$652,828	$652,828
GFR for HA items	-----	$345,567	$345,567	-----	$345,567	$345,567
Light picking for HA items	-----	-----	$568,863	-----	-----	$568,863
Total	$682,383	$1,027,950	$1,596,813	$1,335,211	$1,680,778	$2,249,641
Discounted Payback by Improvement (years)						
New Layout / Split Items	0.82	0.82	0.82	0.82	0.82	0.82
Carousels for LA items	----	----	----	1.32	1.32	1.32
GFR for HA items	----	0.69	0.69	----	0.69	0.69
Light picking for HA items	----	----	2.66	----	----	2.66
Total	0.82	0.77	1.30	1.05	0.97	1.30
Discounted Rate of Return by Improvement						
New Layout / Split Items	129%	129%	129%	129%	129%	129%
Carousels for LA items	---	---	---	78%	78%	78%
GFR for HA items	---	154%	154%	---	154%	154%
Light picking for HA items	---	---	33%	---	---	33%
Total	129%	137%	80%	100%	108%	79%

HA = High Activity LA = Low Activity FTE = Full Time Equivalent

Notes on Calculations:

1. Net present value and discounted payback calculations use 8 percent cost of capital. They also use five year planning horizon.

CASH FLOW STREAMS USED

Improvement	Year	Alternative 1	2	3	4	5	6
New Layout / Split	0	($109,375)	($109,375)	($109,375)	($109,375)	($109,375)	($109,375)
	1	$143,514	$143,514	$143,514	$143,514	$143,514	$143,514
	2	$143,514	$143,514	$143,514	$143,514	$143,514	$143,514
	3	$143,514	$143,514	$143,514	$143,514	$143,514	$143,514
	4	$143,514	$143,514	$143,514	$143,514	$143,514	$143,514
	5	$143,514	$143,514	$143,514	$143,514	$143,514	$143,514
Carousels for LA items	0	$0	$0	$0	($151,525)	($151,525)	($151,525)
	1	$0	$0	$0	$125,555	$125,555	$125,555
	2	$0	$0	$0	$125,555	$125,555	$125,555
	3	$0	$0	$0	$125,555	$125,555	$125,555
	4	$0	$0	$0	$125,555	$125,555	$125,555
	5	$0	$0	$0	$125,555	$125,555	$125,555
GFR for HA items	0	$0	($48,000)	($48,000)	$0	($48,000)	($48,000)
	1	$0	$74,528	$74,528	$0	$74,528	$74,528
	2	$0	$74,528	$74,528	$0	$74,528	$74,528
	3	$0	$74,528	$74,528	$0	$74,528	$74,528
	4	$0	$74,528	$74,528	$0	$74,528	$74,528
	5	$0	$74,528	$74,528	$0	$74,528	$74,528
Light picking for HA items	0	$0	$0	($208,650)	$0	$0	($208,650)
	1	$0	($0)	$90,218	$0	($0)	$90,218
	2	$0	($0)	$90,218	$0	($0)	$90,218
	3	$0	($0)	$90,218	$0	($0)	$90,218
	4	$0	($0)	$90,218	$0	($0)	$90,218
	5	$0	($0)	$90,218	$0	($0)	$90,218
Total	0	($109,375)	($157,375)	($366,025)	($260,900)	($308,900)	($517,550)
	1	$143,514	$218,041	$308,259	$269,068	$343,596	$433,813
	2	$143,514	$218,041	$308,259	$269,068	$343,596	$433,813
	3	$143,514	$218,041	$308,259	$269,068	$343,596	$433,813
	4	$143,514	$218,041	$308,259	$269,068	$343,596	$433,813
	5	$143,514	$218,041	$308,259	$269,068	$343,596	$433,813

SUMMARY OF RESULTS Worst Case

Measure	Alternative 1	2	3	4	5	6
Costs (dollars)	$109,375	$157,375	$366,025	$260,900	$308,900	$517,550
Annual Savings (dollars)	$143,514	$218,041	$308,259	$269,068	$343,596	$433,813
FTE Reduction	3.6	5.4	7.7	6.7	8.6	10.8
Net Present Value	$682,383	$1,027,950	$1,596,813	$1,335,211	$1,680,778	$2,249,641
Discounted Payback Period (years)	0.82	0.77	1.30	1.05	0.97	1.30
Internal Rate of Return	129%	137%	80%	100%	108%	79%

FTE = Full Time Equivalent

Notes on Calculations:

1. Net present value and discounted payback calculations use 8 percent cost of capital. They also use five year planning horizon.

IMPACT OF IMPROVEMENTS

Measure	New Layout/ Split Items	Carou- sels	Flow Racks	Light Aids
Costs (dollars)	$109,375	$151,525	$48,000	$208,650
Annual Savings (dollars)	$143,514	$125,555	$74,528	$90,218
FTE Reduction	3.6	3.1	1.9	2.2
Net Present Value	$682,383	$652,828	$345,567	$568,863
Discounted Payback Period (years)	0.82	1.32	0.69	2.66
Internal Rate of Return	129%	78%	154%	33%

FTE = Full Time Equivalent

Notes on Calculations:

1. Net present value and discounted payback calculations use 8 percent cost of capital. They also use five year planning horizon.

Enter E, B, or W: B Best Case

INPUT PARAMETERS

FIXED PARAMETERS

Low Activity Lines	1096
High Activity Lines	4396
Current Pick Rate	60.0
Hrs to Complete Picks	8.0
Utilization Factor	0.875
Fill In Percent	0.143
Fork Lift Drivers - old	1.0
Fork Lift Drivers - new	1.0
Consolidators - old	2.0
Consolidators - new	0.0
No Packers - old layout	4.9
No Packers - new layout	3.0
Annual Employee Cost	40120

COST PARAMETERS

New Layout Rewarehousing	9000
New Layout Conveyor	46500
Random Case Sealer	32000
Carousel Equipment	89100
Carousel Hardware	6000
Carousel Software	21000
Carousel Interface	5120
Flow Racks	38400
Light Picking Equipment	76800
Light Picking Software	75000
Light Picking Hardware	10000
Light Picking Interface	5120

SENSITIVE PARAMETERS	This Case	Worst	Expected	Best
Low Act Split Factor	-15%	-45%	-30%	-15%
Low Act Carous Factor	225%	75%	150%	225%
High Act Split Factor	45%	15%	30%	45%
High Act GFR Factor	75%	25%	50%	75%
High Act Light Factor	150%	50%	100%	150%
Cost Escalation Fact	-25%	25%	0%	-25%
SF Savings Fact	100%	-100%	0%	100%

ALTERNATIVES (1=Y,0=N)	Base	1	2	3	4	5	6
low act - split	0	1	1	1	1	1	1
low act - carousels	0	0	0	0	1	1	1
high act - split	0	1	1	1	1	1	1
high act - flow racks	0	0	1	1	0	1	1
high act - lights	0	0	0	1	0	0	1

PRODUCTIVITY MODEL

		Alternative -->					
PRODUCTIVITY/ZONES	Base	1	2	3	4	5	6
low act - base LPH	60	60	60	60	60	60	60
low act - split	0	-9	-9	-9	-9	-9	-9
low act - carousels	0	0	0	0	135	135	135
high act - base LPH	60	60	60	60	60	60	60
high act - split	0	27	27	27	27	27	27
high act - flow racks	0	0	45	45	0	45	45
high act - lights	0	0	0	90	0	0	90
Low Activity LPH	60.0	51.0	51.0	51.0	186.0	186.0	186.0
High Activity LPH	60.0	87.0	132.0	222.0	87.0	132.0	222.0
Low Activity Hrs	18.3	21.5	21.5	21.5	5.9	5.9	5.9
High Activity Hrs	73.3	50.5	33.3	19.8	50.5	33.3	19.8
Low Activity Zones	2.6	3.1	3.1	3.1	0.8	0.8	0.8
High Activity Zones	10.5	7.2	4.8	2.8	7.2	4.8	2.8
Total Zones	13.1	10.3	7.8	5.9	8.1	5.6	3.7
WORK FORCE REQUIREMENTS							
Pickers	13.1	10.3	7.8	5.9	8.1	[illegible]	3.7
Consolidators	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Pack/Ship	4.9	3.0	3.0	3.0	3.0	3.0	3.0
Forklift	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Fill In	3.0	2.0	1.7	1.4	1.7	1.4	1.1
Total	24.0	16.3	13.5	11.3	13.8	11.0	8.8
Manpower Savings	0.0	7.6	10.5	12.7	10.2	13.0	15.2
MANPOWER SAVINGS BREAKDOWN (each category includes fill in)							
Due to Realignment	0.0	4.5	4.5	4.5	4.5	4.5	4.5
Due to Low Act Split	-0.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Due to Low Act Carousels	-0.0	-0.0	-0.0	-0.0	2.5	2.5	2.5
Due to High Act Split	-0.0	3.7	3.7	3.7	3.7	3.7	3.7
Due to High Act GFR	-0.0	-0.0	2.8	2.8	-0.0	2.8	2.8
Due to High Act Lights	-0.0	-0.0	0.0	2.2	-0.0	0.0	2.2
Total	-0.0	7.6	10.5	12.7	10.2	13.0	15.2

MARGINAL COSTS

Cost Items	Alternative 1	2	3	4	5	6
New Layout / Split						
rewarehousing of 3000 items	$6,750	$6,750	$6,750	$6,750	$6,750	$6,750
300 ft accumulating power conv	$34,875	$34,875	$34,875	$34,875	$34,875	$34,875
case sealer	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000
Carousels for low activity items						
3483 cubic feet carousel storage	$0	$0	$0	$66,825	$66,825	$66,825
hardware	$0	$0	$0	$4,500	$4,500	$4,500
software	$0	$0	$0	$15,750	$15,750	$15,750
in-house software interface	$0	$0	$0	$3,840	$3,840	$3,840
Gravity Flow Racks for HA items						
4320 cubic feet flow rack storage	$0	$28,800	$28,800	$0	$28,800	$28,800
Light picking for high activity items						
384 lights	$0	$0	$57,600	$0	$0	$57,600
software	$0	$0	$56,250	$0	$0	$56,250
hardware	$0	$0	$7,500	$0	$0	$7,500
in-house software interface	$0	$0	$3,840	$0	$0	$3,840
Costs by Improvement						
New Layout/Split	$65,625	$65,625	$65,625	$65,625	$65,625	$65,625
Carousels for LA items	$0	$0	$0	$90,915	$90,915	$90,915
GFR for HA items	$0	$28,800	$28,800	$0	$28,800	$28,800
Light picking for HA items	$0	$0	$125,190	$0	$0	$125,190
Total	$65,625	$94,425	$219,615	$156,540	$185,340	$310,530

Notes on Calculations:

1. Rewarehousing costs calculated at $30 per hour for 300 hours.
2. Conveyor costs estimated at $50 per linear foot for equipment and $25 per foot for electrical and mechanical systems (400 feet). Also included are 3 drives at $2000 each and seven 90 degree turns at $1500 each.
3. Case sealer cost of $32,000 includes capability to seal random sized cartons.
4. Carousel cost includes six 36 carrier units with carriers 6 feet high by 21.5 inches wide by 18 inches deep. Also includes $15,000 for options.
5. Carousel hardware costs include 3 workstations and 1 server.
6. Carousel software costs include batching and full database capability.
7. In-house software development costs estimated at $32 per man hour. Estimate of 160 hours for carousel interface and 160 hours for gravity flow rack light picking interface used.
8. Flow rack costs estimated at $100 per slot for 384 slots.
9. Gravity flow rack light picking costs estimated at $200 per light plus $75,000 for software control. $10,000 added for computer hardware needed.

MARGINAL SAVINGS

Savings Category	Alternative 1	2	3	4	5	6
5,000 SF Floorspace	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000
Labor Savings	$306,673	$419,515	$507,960	$408,879	$521,722	$610,166
Savings by Improvement						
New Layout / Split	$331,673	$331,673	$331,673	$331,673	$331,673	$331,673
Carousels for LA items	($0)	($0)	($0)	$102,207	$102,207	$102,207
GFR for HA items	($0)	$112,843	$112,843	($0)	$112,843	$112,843
Light picking for HA items	($0)	$0	$88,444	($0)	$0	$88,444
Total Savings	$331,673	$444,515	$532,960	$433,879	$546,722	$635,166

Notes on Calculations:

1. Floorspace savings valued at $2.50 per square foot.
2. Currently using 20,000 SF at each MDC. New layout requires 15,000 SF.
3. Labor savings valued at average annual rate of $34,000 per employee plus 18 percent for benefits.

FINANCIAL ANALYSIS OF ALTERNATIVES

Measure	Alternative 1	2	3	4	5	6
Costs by Improvement						
New Layout / Split Items	$65,625	$65,625	$65,625	$65,625	$65,625	$65,625
Carousels for LA items	$0	$0	$0	$90,915	$90,915	$90,915
GFR for HA items	$0	$28,800	$28,800	$0	$28,800	$28,800
Light picking for HA items	$0	$0	$125,190	$0	$0	$125,190
Total	$65,625	$94,425	$219,615	$156,540	$185,340	$310,530
Annual Dollar Savings by Improvement						
New Layout / Split Items	$331,673	$331,673	$331,673	$331,673	$331,673	$331,673
Carousels for LA items	($0)	($0)	($0)	$102,207	$102,207	$102,207
GFR for HA items	($0)	$112,843	$112,843	($0)	$112,843	$112,843
Light picking for HA items	($0)	$0	$88,444	($0)	$0	$88,444
Total	$331,673	$444,515	$532,960	$433,879	$546,722	$635,166
FTE Reduction by Improvement						
New Layout / Split Items	7.6	7.6	7.6	7.6	7.6	7.6
Carousels for LA items	0.0	0.0	0.0	2.5	2.5	2.5
GFR for HA items	0.0	2.8	2.8	0.0	2.8	2.8
Light picking for HA items	0.0	0.0	2.2	0.0	0.0	2.2
Total	7.6	10.5	12.7	10.2	13.0	15.2

FINANCIAL ANALYSIS OF ALTERNATIVES (continued)

Measure	Alternative 1	2	3	4	5	6
Net Present Value by Improvement (current dollars)						
New Layout / Split Items	$1,389,898	$1,389,898	$1,389,898	$1,389,898	$1,389,898	$1,389,898
Carousels for LA items	-----	-----	-----	$498,997	$498,997	$498,997
GFR for HA items	-----	$479,349	$479,349	-----	$479,349	$479,349
Light picking for HA items	-----	-----	$478,323	-----	-----	$478,323
Total	$1,389,898	$1,869,246	$2,347,569	$1,888,894	$2,368,243	$2,846,566
Discounted Payback by Improvement (years)						
New Layout / Split Items	0.21	0.21	0.21	0.21	0.21	0.21
Carousels for LA items	----	----	----	0.96	0.96	0.96
GFR for HA items	----	0.27	0.27	----	0.27	0.27
Light picking for HA items	----	----	1.56	----	----	1.56
Total	0.21	0.22	0.44	0.38	0.36	0.52
Discounted Rate of Return by Improvement						
New Layout / Split Items	505%	505%	505%	505%	505%	505%
Carousels for LA items	---	---	---	110%	110%	110%
GFR for HA items	---	392%	392%	---	392%	392%
Light picking for HA items	---	---	65%	---	---	65%
Total	505%	471%	242%	277%	295%	204%

HA = High Activity LA = Low Activity FTE = Full Time Equivalent

Notes on Calculations:

1. Net present value and discounted payback calculations use 8 percent cost of capital. They also use five year planning horizon.

CASH FLOW STREAMS USED

Improvement	Year	Alternative 1	2	3	4	5	6
New Layout / Split	0	($65,625)	($65,625)	($65,625)	($65,625)	($65,625)	($65,625)
	1	$331,673	$331,673	$331,673	$331,673	$331,673	$331,673
	2	$331,673	$331,673	$331,673	$331,673	$331,673	$331,673
	3	$331,673	$331,673	$331,673	$331,673	$331,673	$331,673
	4	$331,673	$331,673	$331,673	$331,673	$331,673	$331,673
	5	$331,673	$331,673	$331,673	$331,673	$331,673	$331,673
Carousels for LA items	0	$0	$0	$0	($90,915)	($90,915)	($90,915)
	1	($0)	($0)	($0)	$102,207	$102,207	$102,207
	2	($0)	($0)	($0)	$102,207	$102,207	$102,207
	3	($0)	($0)	($0)	$102,207	$102,207	$102,207
	4	($0)	($0)	($0)	$102,207	$102,207	$102,207
	5	($0)	($0)	($0)	$102,207	$102,207	$102,207
GFR for HA items	0	$0	($28,800)	($28,800)	$0	($28,800)	($28,800)
	1	($0)	$112,843	$112,843	($0)	$112,843	$112,843
	2	($0)	$112,843	$112,843	($0)	$112,843	$112,843
	3	($0)	$112,843	$112,843	($0)	$112,843	$112,843
	4	($0)	$112,843	$112,843	($0)	$112,843	$112,843
	5	($0)	$112,843	$112,843	($0)	$112,843	$112,843
Light picking for HA items	0	$0	$0	($125,190)	$0	$0	($125,190)
	1	($0)	$0	$88,444	($0)	$0	$88,444
	2	($0)	$0	$88,444	($0)	$0	$88,444
	3	($0)	$0	$88,444	($0)	$0	$88,444
	4	($0)	$0	$88,444	($0)	$0	$88,444
	5	($0)	$0	$88,444	($0)	$0	$88,444
Total	0	($65,625)	($94,425)	($219,615)	($156,540)	($185,340)	($310,530)
	1	$331,673	$444,515	$532,960	$433,879	$546,722	$635,166
	2	$331,673	$444,515	$532,960	$433,879	$546,722	$635,166
	3	$331,673	$444,515	$532,960	$433,879	$546,722	$635,166
	4	$331,673	$444,515	$532,960	$433,879	$546,722	$635,166
	5	$331,673	$444,515	$532,960	$433,879	$546,722	$635,166

SUMMARY OF RESULTS Best Case

Measure	Alternative 1	2	3	4	5	6
Costs (dollars)	$65,625	$94,425	$219,615	$156,540	$185,340	$310,530
Annual Savings (dollars)	$331,673	$444,515	$532,960	$433,879	$546,722	$635,166
FTE Reduction	7.6	10.5	12.7	10.2	13.0	15.2
Net Present Value	$1,389,898	$1,869,246	$2,347,569	$1,888,894	$2,368,243	$2,846,566
Discounted Payback Period (years)	0.21	0.22	0.44	0.38	0.36	0.52
Internal Rate of Return	505%	471%	242%	277%	295%	204%

FTE = Full Time Equivalent

Notes on Calculations:

1. Net present value and discounted payback calculations use 8 percent cost of capital. They also use five year planning horizon.

IMPACT OF IMPROVEMENTS

Measure	New Layout/ Split Items	Carou-sels	Flow Racks	Light Aids
Costs (dollars)	$65,625	$90,915	$28,800	$125,190
Annual Savings (dollars)	$331,673	$102,207	$112,843	$88,444
FTE Reduction	7.6	2.5	2.8	2.2
Net Present Value	$1,389,898	$498,997	$479,349	$478,323
Discounted Payback Period (years)	0.21	0.96	0.27	1.56
Internal Rate of Return	505%	110%	392%	65%

FTE = Full Time Equivalent

Notes on Calculations:

1. Net present value and discounted payback calculations use 8 percent cost of capital. They also use five year planning horizon.

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12a. DISTRIBUTION/AVAILABILITY STATEMENT

A: Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT ***(Maximum 200 words)***

The United States Postal Service (USPS) distributes supplies, repair parts, and equipment across the country from materiel distribution centers (MDCs) in Somerville, N.J., and Topeka, Kan. Those MDCs ship both loose-issue and case-lot quantities of materiel, and each devotes the equivalent of 24 full-time employees to its loose-issue pick-and-pack operations. USPS Materiel Distribution seeks to find more cost-effective ways to manage those loose-issue pick-and-pack operations while at the same time maintaining current service response times to its customers.

The USPS can eliminate between 11 and 15 full-time employees at each MDC by reconfiguring its supply pick lines and investing in new material-handling technology. We recommend a new layout for this reconfiguration that uses one line instead of three and increases the amount of product directly accessible to pickers on the line from 28 percent to 60 percent. It is focused around separating high-activity items from low-activity items and treating them differently. The 341 high-activity items would be stored in gravity flow racks with pick lights attached to each location for improved pick productivity. The 2,147 low-activity items would be stored in horizontal carousels utilizing batch-pick software and light pick aids. Orders would be picked sequentially from zones in a pick-and-pass fashion to eliminate the need for consolidation. The reconfigured line would contain an early exit for orders completed before they have traveled through all zones. The pack operation on the new line should be automated as much as possible; our proposed layout utilizes a random case sealer for most outgoing containers. Packing is treated as another zone on the pick line. The new layout would cost approximately $414,000 at each MDC and would require 1 year to develop and install; it would then pay for itself in less than a year.

14. SUBJECT TERMS

Supplies, picking, warehousing, distribution

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